Determination of Construction Contract Duration For Public Projects in Saudi Arabia

by

Ahmed Saleh Al-Sultan

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

June, 1989

Order Number 1360400

Determination of construction contract duration for public projects in Saudi Arabia

Al-Sultan, Ahmed Saleh, M.S.

King Fahd University of Petroleum and Minerals (Saudi Arabia), 1989

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

DETERMINATION OF CONSTRUCTION CONTRACT DURATION FOR PUBLIC PROJECTS IN SAUDI ARABIA

BY

Ahmed Saleh Al- Sultan

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTON ENGINEERING AND MAMAGEMENT

JUNE, 1989

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

DHAHRAN 31261, SAUDI ARABIA

COLLEGE OF GRADUATE STUDIES

This thesis, written by **AHMED SALEH AL-SULTAN** under the direction of his Thesis Advisor and approved by his Thesis Committee, has been presented to and accepted by the Dean of the College of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **CONSTRUCTION ENGINEERING AND MANAGEMENT**.

<u>Thesis Committee</u>

Thesis Advisor

Member

Member

Member

6/6/89

Department Chairman

Dean, College of Graduate Studies

2-7-1989

Date

I dedicate this work to my late father

ACKNOWLEDGEMENTS

Acknowledgement is due to King Fahd University of Petroleum and Minerals for its support of this research.

I wish to express my sincere appreciation to Dr. Soliman Al Mohawis who served as Thesis Committee Chairman.

Thanks are extended to other members of my thesis committee, Dr. Munir Ahmed, Dr. Sadi Assaf, and Dr. Shukri Al Senan, for their constructive comments.

Thanks are also due to all participants in this research.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

THESIS ABSTRACT

Full Name of Student	:	Ahmed Saleh Al-Sultan
Title of Study	:	Determination of Construction Contract Duration for Public Projects in Saudi Arabia
Major Field	:	Construction Engineering And Management
Date of Degree	:	JUNE 1989

This thesis surveyed and evaluated the current practice applied by Government Authorities to determine construction contract duration (CCD) for public projects. Mail surveys were sent to 70 Government Agencies believed to be the population of the study. The results, generated from 47 responses, were analyzed using the computer statistical package (SAS). It was found that there are no specific engineering methods or formal procedures followed by Government Agencies to determine CCD. Rather, three cases seem to exist. These cases are: CCD is set or determined by environmental constraints (budget allocations, certain need, etc.), CCD is set by owner (based on subjective or objective judgement), and CCD is set by other parties (consultants, contractors). The Government Procurement Regulations should establish guidelines to improve the practice of setting CCD. Concerned government authorities are urged to develop engineering methods and written procedures to help engineers determine a reasonable CCD. A model for CCD determination is recommended at the end of this study. The model consists of seven steps and is depicted in a flow chart.

MASTER OF SCIENCE DEGREE
KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DHAHRAN, SAUDI ARABIA

بســــــــم الله الرحمن الرحيم

تحديد مدة تنفيذ المشاريع العامة فى المملكة العربية السعودية.

(أحمد صالح السلطان)

الخلاصـــــــــــة

يهدف هذا البحث الى دراسة وتقويم الطرق التى تتبعها الادارات الحكومية لتحديد مدة تنفيذ المشاريع الانشائية ومن ثم تقديم مقترحات وتوصيات لتطوير هذه الطرق ، وقد تم تصميم استبانة وزعت على (٧٠) ادارة حكومية يعتقد انها جميع الادارات الحكومية المعنية بتنفيذ المشاريع .

ودلت نتائج الدراسة التى تم استنتاجها من (٤٧) استبانة تمت تعبئتها وتحليلها بالحاسب الآلى أنه لا توجد فى الوقت الحاضر طريقة هندسية محددة أو اجراءات منظمة ومكتوبة تتبعها الادارات الحكومية فى تحديد مدة تنفيذ مشاريعها وانما يتم تحديد المدة حسب ظروف المشروع (مخصصات الميزانية ، احتياجات المدينة) أو يحدد المالك مدة معينة (حسب خبرته أو الجداول الزمنية) وفى أحيان أخرى يحدد الاستشارى أو المقاول المدة.

وحيث أن نظام تأمين مشتروات الحكومة لم ينص على تحديد المدة فى أى فقرة (سواء بالنظام الأساسى أو اللائحة التنفيذية) فان الخطوة الأولى يجب أن تتم عن طريق وضع قواعد فى النظام لتحديد مدة تنفيذ المشاريع .

كما ان على الادارات الحكومية المعنية كوزارة الشئون البلدية والقروية والمواصلات والأشغال العامة تطوير طرق هندسية واجراءات محددة لتساعد المهندسين المختصين على تحديد مدة تنفيذ مناسبة للمشاريع .

وفى نهاية هذه الدراسة تم تطوير نموذج لتحديد مدة تنفيذ المشاريع يتكون من سبع خطوات وتم توضيحه بالشكل الهندسى المرفق .

CHAPTER 1

INTRODUCTION

A very important provision in the documents of any construction contract is the duration specified, i.e., the amount of time given to the contractor to execute the work described by the plans and specifications. The issue of time in construction projects is vital for both the owner and the contractor. Construction duration will determine the date on which the project will be in use, the cost to be paid to the contractor to do it, and, also for the contractor, the amount and density of resources needed to execute the job in the specified time.

The issue of construction contract duration, which will be abbreviated as CCD in the rest of this thesis, can be related to the Saudi construction environment by identifying the role of the public sector in the construction industry. This role can be viewed from two perspectives: first, in terms of public spending on construction, and second, in terms of the time-related regulations issued by the concerned Government agencies.

1.1 PUBLIC SPENDING ON CONSTRUCTION

Saudi Arabia has gone through an unprecedented construction experience during the last fifteen years. The construction industry received 49.6% of total Government spending during the first development plan

(1970-75), 30% during the second (1975-80), and 49.8% during the third (1980-85). These expenditures totaled about SR 80 billion, SR 700 billion (peak years) and SR 602 billion in the last three development plans respectively. Total Government spending on construction during the fourth plan (1985-90) is expected to be 225 billion SR (Fourth Development Plan, 1985-1990). The above figures show the important role construction is playing in the Saudi economy. Stemming from this fact, the Government set objectives and policies to improve the construction industry during the fourth development plan. They include

- strengthen the Saudi construction industry,
- improve the quality of construction and maintenance,
- increase the productivity and capabilities of contractors, and
- reduce the cost of construction and related maintenance (Fourth Development Plan, p. 224).

1.2 LAWS AND REGULATIONS

Public tendering on construction is governed by "Government Procurement Regulations" which includes 14 articles establishing the basic rules for Government tendering. This legislation was issued by Royal Decree No. M/14 dated 7/4/1397 H (March 27, 1977). The "Rules for Implementation of Tender Regulations" was later issued by the Ministry of Finance and National Economy on 5/5/1397 (April 23, 1977). These rules consist of 40 articles explaining the basic requirements and setting procedures for

Government purchasing. From the time of issuance of these rules till now, they have undergone several changes and/or modifications reflecting the changing economic and construction environment.

As far as CCD is concerned there is no reference in the above regulations regarding the setting of CCD. This issue seems to be left to the project proponent to decide. However, once the construction contract is signed by the Government and the contractor, the CCD specified in the contract becomes binding and enforceable. It is not within the authority of the Government Agency (project owner) to change it.

Aside from setting CCD, the regulation contains three clauses related to CCD: Articles 9/A, 9/B, and 9/C of the basic law treat the issues of time extension and liquidated damages. In article 9/A, 10% of the contract price is stated to be the maximum amount of liquidated damages. Further details of how to calculate these damages can be found in article 37 of the "Rules for Implementation". Article 9/B authorizes the concerned Minister or the Director of the Independent Department to extend CCD when there is delay and it is caused by either

1. a change order involving extra quantities which cannot be executed in the contract's original time, or
2. a work suspension order.

Other than these two cases, the time extension of construction projects can only be done by obtaining approval in coordination with the Ministry of Finance and National Economy.

In brief, it seems that the current Government regulations do not address the issue of CCD before signing the contract, but only afterwards, when contract duration becomes the subject of tight control.

1.3 SIGNIFICANCE OF THE STUDY

During the Saudi construction boom period of 1975-1982, the Government aimed at executing construction projects in the shortest possible time. This policy was instigated by the urgent need for infrastructure projects. Cost at that time had not been given top priority. However, in the following years (post 1982), still more construction projects are needed, but cost and quality are now receiving much more attention than they used to.

CCD, as will be shown in Section 2.1, is directly related to cost. Therefore it is important to review and evaluate the practices related to the determination of CCD of concerned government authorities.

In this study, literature concerning the determination of CCD and its relationship with project cost is reviewed in Chapter 2. A survey of the current practice applied to set CCD for public projects was performed through a questionnaire, the design of which can be found in Chapter 3. The data gathered are presented, analyzed, and discussed in Chapter 4. Conclusions drawn from the research and recommendations related to the research subject are shown in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

In this chapter the literature will be reviewed in three parts: the first part deals with time-cost relationship, the second part deals with setting CCD, and the third part addresses the specifications of CCD.

2.1 TIME/COST TRADEOFF IN CONSTRUCTION

The cost of construction projects can be broken down into two main categories, namely direct and indirect costs. Direct costs are the sum of expenses of labor, equipment, materials and other costs that are directly associated with the physical completion of an activity. As far as these costs are concerned, construction projects have what is called normal time/cost, which is the minimum direct cost required to complete the project, and normal time is the time associated with the minimum direct cost. Crash time/cost is the minimum possible time to construct a project (Roncoli, 1986). The crash time is clearly shorter than normal time, while crash cost is more than the normal cost. This fact is mainly due to the expediting action, such as overtime or multiple shifts (Clough, 1972).

On the other hand, indirect costs could be divided into two types: general overhead and job overhead. General overhead is the cost of doing business and it is time- independent, i.e., it is not affected by the duration of a construction project. Examples of these costs are the salaries of company executives, cost of utilities of the main office, and so on. Job overhead is those costs which are traceable to a certain project but not to a specific construction activity. Some job overhead costs are independent of time, for instance, fencing, haul roads, etc. Some are time-dependent such as the cost of supervision, site office utilities and so on. Generally these time-dependent costs increase linearly with the passage of time.

Based on the above discussion the time/cost curves for a construction project can be drawn; consequently, cost can be optimized. Figure 2.1 illustrates this relationship.

The assumption of linear relationship between direct cost and time (the dotted line in Figure 2.1) simplifies the optimization process. Schedulers usually utilize this assumption prior to performing the so called "least cost scheduling". In this process the optimum mix of direct and indirect costs is obtained and the corresponding CCD is determined. This tradeoff is accomplished after the project network (CPM for instance) has been prepared.

2.2 SETTING CONSTRUCTION CONTRACT DURATION

Many papers, reports, and books have been written discussing the issue of setting CCD.

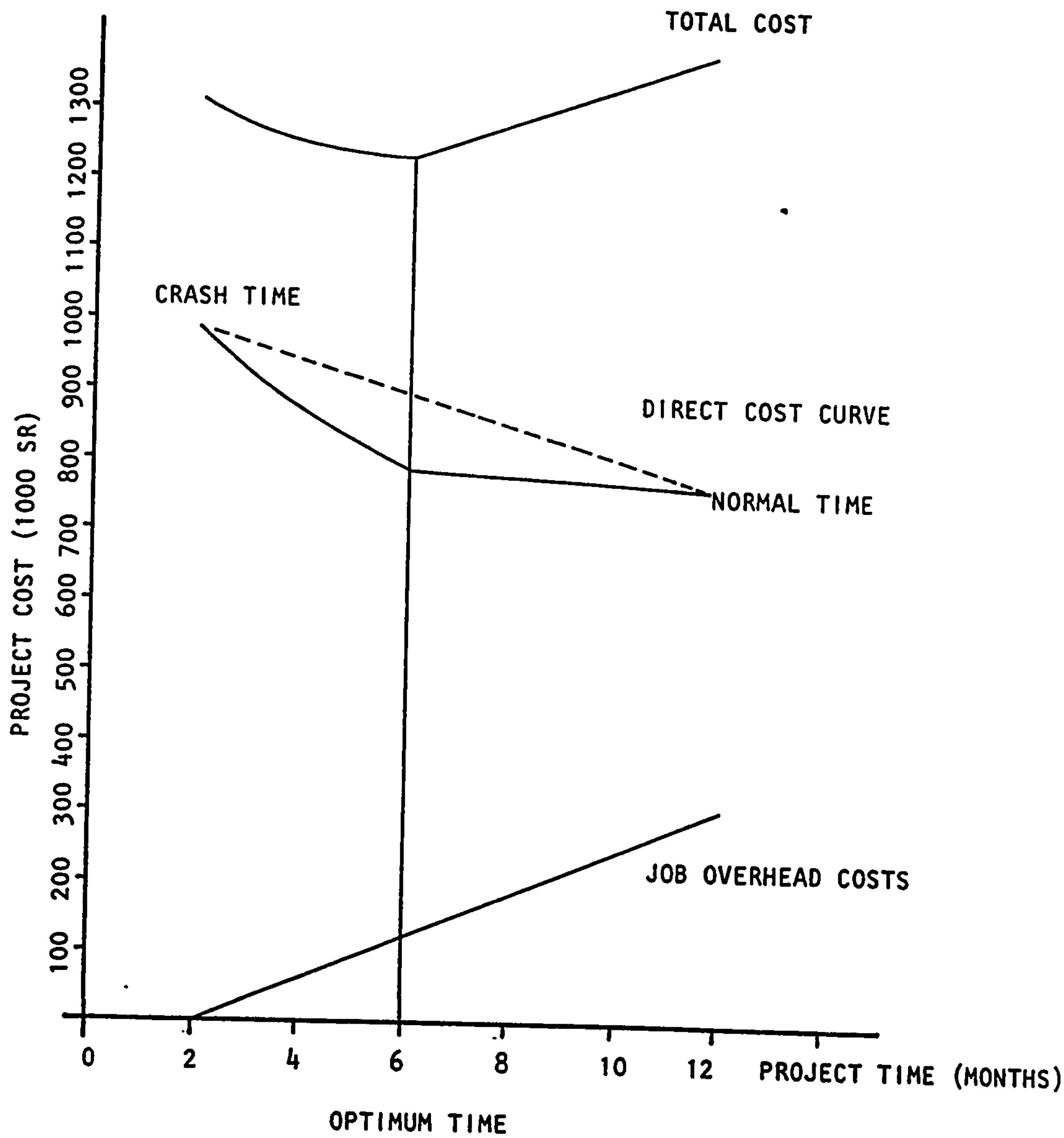

Figure 2.1. Time/cost relationship in construction.
(Rencoli, 1986, p. 22).

The Indiana State Highway Commission (USA) sponsored a research project to investigate current methods of contract time determination (Hancher and Rowings, 1981). The research involved an evaluation of current practice applied to set highway construction contract duration in midwest States (USA) and to develop an improved procedure for contract time determination in Indiana. After reviewing different methods applied by five States, it became evident that every State is using a formal systematic procedure to set contract duration. The outcome of the research was a model developed to estimate highway construction contract duration. The model consists of five steps. In brief those steps are

Step 1: study contract documents,

Step 2: identify time-consuming activities,

Step 3: establish the construction logic,

Step 4: establish the duration for each activity, and

Step 5: establish the start time and finish time for each activity.

Report No. 97 of the National Cooperative Highway Research Program, USA, titled "Contract Time Determination" (Transport Research Board, 1981) stated that the determination of contract time by transportation agencies is primarily based on four methods:

1. construction season limits,
2. quantity or production rate,
3. work flow techniques, and
4. estimated cost.

The construction seasons limits method is used for project which must be finished prior to a certain season, such as surfacing and paving operations. This approach is suitable for Hajj projects in the Kingdom.

The quantity or production rate method involves breaking the project down into the major controlling work items, then using production tables to calculate the construction duration.

For large complicated projects, the use of work flow techniques - such as CPM - is a must, where a lot of coordination effort is needed.

For less complicated projects, the estimated cost may be used to determine the construction duration. The estimated project cost is related to contract time or working days required to complete a particular project. This method is the easiest of the four, but certainly not the most accurate.

Gates and Scarpa are among the most important researchers who wrote several papers about this subject. In their paper "Optimum Working Time" (Gates and Scarpa, 1977), a familiar highway construction management problem is presented, analyzed, and solved. The problem is to determine the optimum working time and number of crews for an operation. The tradeoff is between overhead costs and equipment mobilization costs. An optimizing equation is derived and verified with a trial and error solution. The equation is of the form:

$$T_{opt} = \frac{C_m}{C_{oh}}$$

where T_{opt} is the optimum working time and C_m and C_{oh} are the costs of mobilization and overhead respectively. The researchers concluded that "the optimum working time for a construction operation is when the total cost for variable overheads equals the total cost to mobilize and demobilize all of the crews." (p. 780)

L.F. Heineck (1987) in his paper "A model to estimate the duration of work on house building sites" stated that duration of activities can be related to two different sets of variables: the physical quantity of work done or the quantity of resources consumed. The result of his study was a family of regression models relating the duration (as the dependent variable) to labor consumption (as the independent variable). However, despite the good correlation coefficients of the models (greater than 0.9), the researcher concluded that "the accuracy with which duration might be estimated is deemed to be poor." (p.1)

Studies have also been conducted to evaluate the uncertainty factors affecting CCD. Hira and Nandakumar (1984) investigated the various factors affecting projects duration in order to enhance the reliability of CCD determination.

The researchers identified 21 different uncertainty variables, but the list was later reduced to eight significant variables. These are

- learning curve,
- weather,
- space congestion,
- crew absenteeism,
- regulatory requirements,
- design changes and rework,
- economic conditions, and
- labor unrest.

Then, a model was developed to incorporate the impact of all above uncertainty variables to forecast the expected delay. The project completion time was also forecasted, along with its associated probability.

The time performance of construction projects has been the subject of several researches. In a report to the Australian Institute of Quantity Surveyors (Bromilow, Hinds, and Moody, 1980), the researchers analyzed the actual construction time of 419 building projects completed over the period 1970-1976. Two hundred and ninety of those projects were government projects and 129 were private ones. The analysis showed that the equation of the general form $T = Kc^{B}$, identified previously by Bromilow as describing the relationship between construction time T and Construction Cost C in the 1960s, where B and K are constants, still holds.

A similar study was carried out for New Zealand building contracts (Soeterite and Foster, 1976). The study involves investigating the possible relationship between time and cost of construction of New Zealand commercial building projects. They reported that 65% of the construction time variance can be accounted for in terms of contract cost.

Unfortunately, no literature was found addressing the subject in Saudi Arabia. But there are some studies related to the construction industry in the Kingdom which are useful to this research. A good example of these studies is the one conducted by Al-Hazmi (1987), on the causes of delay in construction in the Eastern Province of the Kingdom. Al-Hazmi identified the most severe factors causing delay in construction. This was achieved through a questionnaire distributed to a selected sample of owners, consultants, and contractors. In the questionnaire, 56 different causes of delay were listed. The analysis showed that causes of delay related to financing are the most severe of all.

2.3 SPECIFICATIONS OF CONSTRUCTION CONTRACT DURATION

CCD is normally expressed in either working days, calendar days, or a fixed date for completion (Thomas, Jones, and Willenbrock, 1985). The working days policy involves specifying a certain number of working days to complete the project. The criteria for charging the contractor a work day must be defined very clearly in the contract documents. The authority to charge working days is usually delegated to the owner's site representative.

This method, the working days, removes some of the risks the contractor has to assume for unforeseen problems. For example, days in which weather conditions, design changes, or any other problem do not allow the contractor to work will not be counted. The major disadvantage of the working days system is the high potential of disputes between the contractor and the owner's representative in regard to the meeting of the definition of a working day. Another drawback of this method is the extra effort needed from the owner to supervise the project. The researcher has other reservations: "work days are not as flexible as they would appear. The owner's representative is normally responsible for administrating the allocation of work days. Criteria for charging the contractor a work day against the contract have been used as penalties rather than for flexible schedule time" Smith (1986, p. 64).

An alternative system to the working days contract is the calendar days contract. In this system, CCD is expressed as a number of calendar days or months. The calendar days method places more risks on the contractor than the working days in regard to CCD. But in return it decreases the disputes potential.

The third method used to specify CCD time is the completion date method. This method is usually used when the owner needs the project at a certain date. Examples of such projects include schools, Hajj projects, etc. The completion date system is not used only in response to project characteristics, but in cases where the owner is not willing, or does not have the facilities, to estimate a reasonable CCD. As explained by Smith (1986), "Some owners are capable of determining times with great accuracy, others tend to rely on their desired completion date rather than realistic construction duration." (p. 64)

The completion date method places more risks on the contractor than the other two methods mentioned above. This is because it is less probable that a time extension is granted in cases of delay.

The choice among the three methods of specifying CCD explained in this section depends on both the owner and the project. It is also worth mentioning that these three methods are not precisely distinctive or mutually exclusive. There are cases in which calendar day contracts and completion date contracts include guaranteed work days or a specific number of days for each month. (Transportation Research Board, 1981).

In regard to the Saudi public construction environment, it was shown in Section 1.2 that granting time extensions for construction projects is limited, by law, to very high authorities (Ministers). This fact makes the working days method impractical, if not impossible. The current standard Government construction contract addresses CCD in article 3 "Contract Duration". It states: "The contractor is to execute and finish all works specified in this contract through a period of   ". A space is left for project owners to fill out. This standard contract does not specify (or necessarily requires) a certain system to be followed in expressing CCD.

CHAPTER 3

METHODOLOGY

In this chapter, the research methodology is presented by first stating the problem. Objectives of the research are then set. Limitations placed on the research scope follow. The main part of this chapter is reserved for the research design in which the questionnaire content is presented along with the pilot study. The population covered is then defined and listed. The last section is devoted to data collection.

3.1 STATEMENT OF THE PROBLEM

Once the tender documents of a public construction project are prepared, the Government Department is faced with the problem of setting the CCD so that contractors can bid on a well defined work. The researcher has worked as a project engineer for seven years in two Government Agencies: Dammam Municipality for five years and Water & Sewage Authority in the Eastern Province for two years. This experience, in addition to preliminary investigations (interviews, telephone calls, and reviewing the files of finished proejcts), revealed the following:

1. There seems to be no systematic methods or a formal procedure applied to set CCD.

2. CCD is set either by top management of the Agency, engineering department or by a hired consultant.
3. Unnecessary severe time limits are placed on contractors.

These observations could be looked at, in the liberal sense, as being hypotheses to be tested. This study raises several questions such as Who sets CCD? and how? What are the consequences of the applied practice? What if contractors are asked to propose CCD with their bids?

In short, the problem of this research is, how government agencies set CCD, given that they have the authority to do so.

3.2 OBJECTIVES

The main objectives of this research are to

1. Investigate the available methods used (internationally) to set CCD and the factors affecting the determination process.
2. Study and evaluate the current practice applied to set CCD for public projects in Saudi Arabia.
3. Make recommendations related to the practice of setting CCD in the Kingdom.

3.3 SCOPE

The research will be limited to public construction projects in Saudi Arabia. The treatment is limited to the owner's point of view. The opinions of consultants, contractors, or project users could be the subjects of other research.

The scope is also limited to projects which the Government Department (project owner) has authority to decide on the setting of CCD.

Another limitation is a financial one. Construction projects of SR.100 million in value or less are under discussion in this research. It is believed that projects costing more than the above limit may need special attention and further considerations. In Government procurement regulations, projects costing more than SR 100 million are the authority of the Council of Ministers to award.

Unlike most of the literature reviewed, this study places no limitation on project type, i.e., roads, buildings, electromechanical, etc. It deals with the management side of the issue more than the engineering side.

3.4 RESEARCH DESIGN

After defining the problem, and stating the objectives of the research, interviews were performed with some of the Government officials heavily involved in construction activities. Telephone calls were also made to some of the engineers working in the design and supervision of public construction projects. This was to expand the researcher's knowledge about the subject in the Kingdom.

It was then decided to develop a questionnaire to be distributed to concerned authorities in order to collect the data needed for the research. The population of the study was then defined, consequently data were gathered for analysis.

In the following sections the questionnaire design is introduced along with the population list and data collection mechanism.

3.4.1 Questionnaire Design

The questionnaire was designed to cover the following issues:

- current practices of setting CCD,
- factors affecting the setting of CCD,
- consequences of short and long CCD,
- assessing the practice of setting CCD by contractors,
- suggested methods of setting CCD,
- personal information of the respondents, and
- construction projects time performance.

One or more questions were written to extract information on the above issues. Special care was exercised in the following aspects:

1. Introducing the research to respondents through a cover letter and providing the guidelines for filling out the questionnaire.
2. Making the task of the respondent as easy as possible by stating every question in such a way as to be as precise, short and as clear as possible while minimizing the amount of writing he has to do through incorporating all possible answers and providing a space for comments.
3. Including only the necessary questions.
4. Logical sequencing of questions.
5. Measuring variables at the highest possible level with the appropriate scale (continuous or discrete).
6. Editing the questionnaire to insure proper language and format.

The questionnaire consists of 18 questions and a table. It is written in Arabic in order to be understandable to all respondents (see appendix A). An English version is also found in appendix B. The following is a detailed discussion of the issues contained in the questionnaire.

3.4.1.1 Current Practice

Based on the observations made in the statement of the problem (Section 3.1), the first question in the questionnaire was raised to answer the following questions:

- How is CCD set? Who sets it? Do the first two observations made in the statement of the problem hold true?
- By what percentages do the three parties (top management, engineering department, and consultants) get involved in setting CCD?
- What other methods are applied to set CCD?
- Do all respondents know about the applied practice at their departments? Or not?

Question No. 3 was then stated to find out the degree of attention given to the duration setting process. Five levels of consideration were listed ranging from "enough attention in all projects" to "no attention at all." The respondent's opinions towards the application of a systematic engineering method to set CCD are measured in question No. 4. Respondent's opinions are registered on a 5-point Likert scale ranging from "extremely important" to "not important". The severity of the time placed on contractors is the subject of question No. 7. An evaluation of the CCD set by the concerned authority is requested. The answer to this question ranges from "very short" to "very long". The corresponding percentages are also asked for. For instance, a respondent might answer that CCD set by his department is "short in 70% of the projects" and "reasonable in 30%".

Apart from what is actually practiced, who should be responsible for setting CCD is investigated in question No. 10. The choice is among

- top management,
- engineering department,
- consultant, or
- joint efforts of the above,

Space is also provided for the respondent to add other parties deemed responsible to participate in the setting process but not listed.

Questions Nos. 11 and 12 ask about scheduling issues: whether it is important to have the contractors submit schedules with their bids or not and is it practiced at the concerned department or not?

3.4.1.2 Factors Affecting CCD

Several factors including financial, engineering, managerial, and environmental affect CCD. The identification of these factors is a very important input to the process of setting CCD. Eight factors believed to be important in determining CCD are identified and listed in Question No. 2. Some of those factors are related to the project itself (cost, design, etc.), some are related to the site, while others are related to the contractor. The responses to these issues were registered on a 5-point Likert scale ranging from extremely important to not important. Space is also provided for other factors not listed that respondents may believe important.

3.4.1.3 Consequences of Short and Long CCD

In the absence of sound engineering methods utilized in the determination of a reasonable CCD, one can expect CCD to be, in many cases, either short or long. Negative consequences of short or long CCD could be seen in every project facing this problem. Employees responsible for the treatment of delayed projects were interviewed to discuss those consequences. Files of some projects experiencing time over runs were reviewed. Through this preliminary survey and by literature review, seven major negative consequences of short CCD were identified and listed in Question No. 5 for the evaluation of the respondents. Examples of these consequences include high bid prices, excessive managerial overburden of delay claims and time extensions, poor performance due to time pressures, and several others.

In the same manner three negative factors of long CCD were included in Question No. 8. These consequences include discouraging effective management and innovations and encouraging contractors to bid more work than can be handled in a timely manner (Transportation Research Board, 1981).

The negativity of the above mentioned consequences is measured on a 5-point ordinal scale ranging from extremely negative to not negative.

Long and short CCD are not without positive effects. The same approach was applied to evaluate these positive effects. The positive consequences of short CCD are explored in Question No. 6. Low bid prices, promoting effective management, and raising the contractors awareness of time importance are examples of positive consequences of short CCD. Positive consequences of long CCD include possible low bid prices, good coordination with other agencies and permitting more contractors to bid. These factors were listed in Question No. 9. The respondent's assessment of the above consequences are measured on a 5-point ordinal scale ranging from extremely positive to not positive.

Beside the above mentioned positive/negative consequences, space is provided at the end of every question (5, 6, 8, and 9) for respondents to add other effects not listed in the questionnaire.

3.4.1.4 Contractor's Participation on Setting CCD

Some of the public projects need not be finished at a specific date. The sooner the better; but, there is some flexibility in setting CCD. Examples of those projects include public parks, upgrading of existing roads, public buildings, etc.

In fact, if we exclude the Hajj projects, schools, and hospitals, most of the public projects might come under this category. It is suggested for those projects to be sent for tendering with a preliminary CCD set by the owner, but it is left to contractors to submit alternative CCD with their bids. Owners then select the best offer in terms of price and time. Question No. 13 tests the applicability of this practice by measuring the opinion of respondents towards its adoption. The answers listed for choice range from "strongly in favour" to "strongly not in favour". Along with every opinion, a space is provided for respondent to justify their choices with reasons (advantages/disadvantages). At the end, space is again provided for comments.

3.4.1.5 Personal Information

The respondent's position is an important factor that might affect his assessment of the issues presented in this survey. This is due to the different perspectives an issue is looked at from different levels of management. Three levels of responsibility are recognized in Question No. 15, namely, general director (top management), engineering director and design/supervision engineer. Other choice is also given for different job positions. The education and experience of respondents are also explored in Questions Nos. 16, 17 & 18. These personal questions were purposely positioned at the end of the questionnaire to enhance returns.

3.4.1.6 Time Performance Table

This table was designed to serve the purpose of evaluating the performance of construction projects timewise. In the case of time over-run and time extension granted, it may imply that CCD was originally underestimated. This table is to be filled with information related to five construction projects already constructed and handed over to owners. The following information are requested for each project:

- total cost,
- CCD set by Government Agency (owner),
- actual CCD, and
- time extensions claimed by contractor.

To increase the project representativeness, the table lists designated years of handover; these were 1980/81, 82/83, 84/85, 86/87, and 88/89. A note at the bottom of the table requested information about projects handed over during the listed years.

3.4.1.7 General Comments

To increase the flexibility of the questionnaire, an open ended question was stated at the end. It is to provide a space for respondents to write their opinions towards possible procedures to be applied to the setting of CCD, such as what factors should be considered when developing a method for this purpose. Respondents may also write any other comment concerning the research subject.

3.4.2 The Pilot Study

Before final production of the questionnaire was completed, a pilot study was performed. A sample of 10 government engineers involved in public construction activities was selected. For convenience the whole sample was taken from Dammam Area. They were asked to fill out the questionnaire. This pilot study served the following:

1. test the adequacy of the questions,
2. point out places of ambiguities,
3. incorporate more possible answers and increase lists of factors and items,
4. review the adequacy of provided spaces for each question, and
5. estimate the time needed to fill out the questionnaire, and determine whether this was reasonable or not.

This pilot run helped detect the ambiguity found in Question No. 1, which was then restated in a more precise manner. Some other relevant factors affecting CCD were also listed by respondents and consequently included in the questionnaire list. Spaces were found adequate. Filling out the questionnaire took about 20 minutes on average. Therefore, it was written in the cover letter that the questionnaire would take 15-25 minutes to fill out.

Later the questionnaire was finally produced and made ready for distribution.

3.4.3 Population Under Study

Stemming from the scope of the research, the population is defined to be all Government departments responsible for executing public construction projects. That is, they have the authority to design (in house or through a consultant), tender, and supervise (in house or through a consultant) their projects. The Government Annual Budget allocation is used as the source of identifying those departments.

The General Department of Statistics in the Ministry of Finance and National Economy issues annually a "Statistical Year Book" which contains, among other statistics, the Government budget appropriated by chapter, item, and section. The twenty-third issue of this book (1987), the latest available, was used to produce the list of Government Departments which satisfy the above population definition. They totaled 42 agencies as follows (listed in the order they appear in the budget):

1. National Guards Presidency
2. Presidency of Youth Welfare
3. General Organizations for Ports
4. King Abdulaziz City for Science & Technology
5. Royal Commission for Jubail & Yanbu
6. Ministry of Defence & Aviation
7. Ministry of Interior
8. Ministry of Municipal & Rural Affairs
9. Municipality of Riyadh

10. Municipality of Jeddah
11. Muncipality of Makkah
12. Municipality of Medina
13. Municipality of Dammam
14. Riyadh Water Department
15. Eastern Water Department
16. Western Water Department
17. Qaseem Water Department
18. Assir Water Department
19. Ministry of Public Works & Housing
20. Ministry of Labour
21. General Organization for Technical Education & Vocational Training
22. Ministry of Health
23. Ministry of Information
24. Ministry of Education
25. Presidency of Girls' Education
26. King Saud University
27. King Abdulaziz University
28. King Fahd University of Petroleum & Minerals
29. University of Al-Emam Mohammed Bin Saud
30. King Faisal University
31. Um Al-Qura University
32. Islamic University
33. Ministry of Communications

34. Railroad Organization
35. Ministry of Post, Telephone, and Telegraph
36. Ministry of Petroleum and Mineral Resources
37. Ministry of Industry and Electricity
38. Ministry of Agriculture and Water
39. General Organization of Desalination
40. Ministry of Pilgrims and Endowments
41. Ministry of Finance and National Economy
42. Civil Aviation.

Further investigations revealed that four of the above mentioned Ministries have more than one Department satisfying the definition of the study population. They are the Ministries of Municipal and Rural Affairs, Public Works, Communications, and Post, Telephone, and Telegraph.

The Ministry of Municipal and Rural Affairs has an Engineering Affairs Department in Riyadh, six General Directorates distributed all over the Kingdom, and five Municipalities of Hail, Taif, Tabouk, Al-Hassa, and Hafer Al Batin. Those Authorities total to 12.

The Ministry of Public Works has eight branches located in different provinces of the Kingdom. Seven Road Authorities report to the Ministry of Communications. Each one is satisfying the definition of the population. There are four main branches of the Ministry of Post, Telephone, and Telegraph.

According to the above breakdown, the total population is up to 70 authorities. This is a liberal estimate, since some of the above agencies might not actually satisfy the definition of the population. In some cases an agency having its own budget may depend on other agencies for engineering services. An example of these agencies is the Ministry of Pilgrims and Endowments which relies on the Ministry of Public Works to supervise the construction of some of its projects. But, to be conservative, the population was considered to consist of all the above agencies; and since it is relatively small (70 agencies), no sampling scheme was used. It was decided to survey the entire population.

In the Agencies mentioned above, the questionnaire should be filled out by the directors of projects departments as they are expected to know most about the research subject. The cover letter explicitly states this.

3.4.4 Data Collection

As can be seen in the previous section, the population is dispersed all over the Kingdom which is a very large country. Mail surveys were adopted. Accordingly the questionnaire was designed to be self explanatory.

An official letter signed by the Dean of the College of Environmental Design at KFUPM was sent to every Government Agency member of the population. This letter conveys the following information:

- introduction to the research,
- suggestion of who may fill out the questionnaire,
- the address to which the questionnaire is to be returned, and
- assurance that all information written will be used only for research purposes.

Necessary copies of the questionnaire were prepared and sent on January 15, 1989.

Sixteen filled questionnaires were returned (approximately 23% of the total) within the first month. Within two months 33 filled questionnaires were returned (approximately 47% of the total). Then a letter of follow up was sent on March 10, 1989 to those who did not respond. The letter reminded them about the questionnaire and asks for response; an additional copy of the questionnaire was also attached. By the 15th of April 1989 total responses reached to 47 (approximately 67% of all questionnaires sent). This return rate is impressive and it could be attributed to the following factors:

1. the importance of the research subject;
2. the complete information conveyed in the cover letter, especially who is to complete the questionnaire and the return address;
3. the reasonable time it takes to complete the questionnaire; and
4. The formal correspondence approach.

These 47 completed questionnaires were used for the analysis.

Since the data are to be analyzed using the SAS (Statistical Analysis Systems) package available at the Data Processing Center of KFUPM, a coding scheme was adopted to translate every piece of information in each questionnaire, except unstructured comments, to a number. Every questionnaire, by arrival, was examined carefully and data were coded in a special sheet and entered into an SAS file. The coding scheme was tested and verified. Data were also checked from a hard copy (computer printout) to the original questionnaire to confirm the accuracy of both coding and entry.

CHAPTER 4

RESULTS AND ANALYSIS

The information collected in this survey are grouped into two main categories: data and comments.

Data were obtained by responses to either a multiple choice question or to a specific information request to be filled in a given space. Data are either on nominal, oridinal, interval, or ratio scales based on the nature of the variable measured. All of these data were entered in the computer using a coding scheme designed for this purpose. Most of the research results were drawn from this group.

Comments are information written by the respondents in response to open ended questions. After examining these comments no pattern was found and none of them was incorporated in the data. But they were grouped question by question in order for them to be summarized and analyzed.

According to the above information classification, data were analyzed using computer, while comments were manually analyzed.

This chapter introduces the statistical techniques used to analyze the data and then presents and discusses the results.

4.1 STATISTICAL TECHNIQUES

The statistical methods used in this study are governed by two factors: nature of the data collected (level of measurement) and the required results. The following sections present the statistical techniques used and the justification for their use.

4.1.1 Descriptive Statistics

All the structured data of this research were summarized by calculating means, standard deviations, coefficients of variation, and the minimum and the maximum for each numeric variable. Respondent's comments produced by open-ended responses were summarized manually by grouping similar opinions or comments and trying to relate them to the respondent's professional and educational backgrounds or to any other relevant variables in the survey.

4.1.2 Cross Tabulations

Contingency tables were produced by cross tabulating the values of two variables. Contingency tables help in detecting possible relationships between two variables on a nominal scale, and or ordinal scale. Section 4.1.4 addresses the test of independence of the null hypothesis regarding the independence between two variables in a contingency table.

4.1.3 Correlation Analysis

Researchers are often interested in measuring the extent to which two variables are related. The knowledge of how one variable varies with another makes predictions and manipulations possible. In this study, for instance, it would be useful to know whether the opinion of respondents towards the practice of setting CCD by contractors (measured at ordinal scale) varies significantly with their years of experiences (measured at ratio scale). If the opinion varies positively with experience, there will be more justification to the recommendation of using this practice. A statistical technique called correlation is usually used to measure the strength and direction of the relationship between two variables. In correlation analysis the two variables of concern are assumed to be random variables and normally distributed (Anderson et al, 1981).

For the purpose of this research, "r" is calculated using the "PROC CORR" subprogram of SAS which produces the Pearson's product moment correlation coefficient.

4.1.4 Test of Independence

Not all variables in this research satisfy the normality assumption stated prior to the calculation of the correlation coefficient. Examples of these variables include the respondent's position, education, etc. When a variable of this nature (usually on a nominal scale) is to be related to another variable, the two variables are cross tabulated and then the relationship is examined by a statistical technique known as "test of independence".

For illustration purposes, consider the relationship between a respondent's position and his evaluation of the need to develop a systematic method to set CCD. A concern of this research is to determine whether the evaluation is independent of position or not. Statistically speaking, test of independence involves testing the following hypotheses (H_0 and H_A are the null and alternative hypotheses respectively):

H_0 : evaluation is independent of position,

H_A : evaluation is not independent of position.

The Chi-square test will be used to test this hypothesis. At the end of this chapter an end note discusses the validity of the Chi-square test in cases of small expected cell frequencies which is encountered quite frequently in this research. The policy adopted in this study is to consider the Chi-square test valid even for very small cell frequencies.

4.1.4 Ranking

Five questions in the survey contain lists of factors and consequences of practices. These factors/consequences were ranked according to their importance or positivity/negativity. For this purpose the arithmetic mean response for each factor/consequence is determined.

4.2 RESULTS AND DISCUSSION

The results of this study are generated from 47 responses to the questionnaires mailed to 70 Government Agencies which represent the population of the study (see section 3.4.3). The rate of return is 67% which is quite impressive for mail surveys. The cover letter of the questionnaire asked that the questionnaire be filled out by the director of projects department or a similar position. Only 50% of the returned questionnaires were filled out by persons who are directors of projects departments or similar positions. Other participants include eight general directors, nine design/ construction engineers and seven other positions. All respondents have at least a Bachelor degree. Seven of them have Masters and two have Ph.Ds. The average experience of respondents is 10.5 years with a standard deviation of 5.0 years. Fourteen respondents have their experience in building construction, 11 respondents in building and road construction, and the remaining are distributed between different construction fields such as electromechanical, water & sewerage, and so on.

The results of the survey were grouped into three main issues: the current practice of setting CCD, the consequences of setting short or long CCD, and alternative approaches to setting CCD. Due to the multiplicity and relative shortness of the various subjects in these issues, "results" and "discussion" for each subsection are grouped by presenting the results and then discussing these results.

4.2.1 Current Practice of Setting CCD

Results related to the current practice of setting CCD will be presented in four related areas: responsible agency of setting CCD, methods of setting CCD, attention paid to setting CCD, and adequacy of set CCD.

4.2.1.1 Responsible Agency for Setting CCD

The first question of the questionnaire requested information about responsible agencies for setting CCD. Forty-three respondents participated and the following results were obtained

- Approximately 91% of the respondents (39 out of 43) reported that CCD is set, at their departments, by either top management, engineering departments, or by a hired consultant. Further breakdown across these groups is found below.
- About two percent (one respondent only) reported: "CCD is set by different departments and by organized manner" no further information was given on who sets CCD or how.
- About 7.0% (three respondents) reported that they don't know who sets CCD or how. These respondents were found to occupy lower positions than other respondents (construction or design engineers).

The results seem to support the preliminary assumption stated at the research design stage that CCD is set by either top management, engineering department, or by a hired consultant. Further detailed information were also obtained regarding the involvement of the three parties mentioned above in setting CCD i.e., by what percentage of projects does top management set CCD. The same analysis applies to the other two parties. Tables 4.1, 4.2, and 4.3 present respondents' reports in detail. Figure 4.1 portrays the three parties involvement in setting CCD. The following statements summarize the results:

- Top managements are involved in setting CCD in 18 departments (out of 43 responses). In these authorities top management sets CCD for a mean percentage of about 21% of the projects.
- Engineering departments are involved in setting CCD in 34 departments (out of 43 responses) in which engineering departments set CCD for a mean percentage of about 67% of the projects.
- Consultants are involved in 20 departments (out of 43 responses) and they set CCD for a mean percentage of about 51% of the projects.

It should be made clear that parties involved are not mutually exclusive, i.e., more than one party may get involved in setting CCD for the same project.

TABLE 4.1. Top Management Involvement in Setting CCD.

% of projects in which CCD is set by Top Management	Frequency No. of respondents
5	2
10	8
20	3
30	4
100	1

TABLE 4.2. Engineering Departments Involvement in Setting CCD.

% of projects in which CCD is set by Engineering Departments	Frequency No. of respondents
10	2
20	2
25	1
30	2
40	2
45	1
50	1
60	1
65	1
70	5
75	1
80	3
90	3
93	1
95	1
98	1
100	6

TABLE 4.3. Consultants Involvement In Setting CCD.

% of projects in which CCD is set by Consultants	Frequency No. of respondents
5	1
7	1
10	1
20	2
25	1
30	1
40	2
45	1
50	1
60	1
70	2
80	2
90	3
100	1

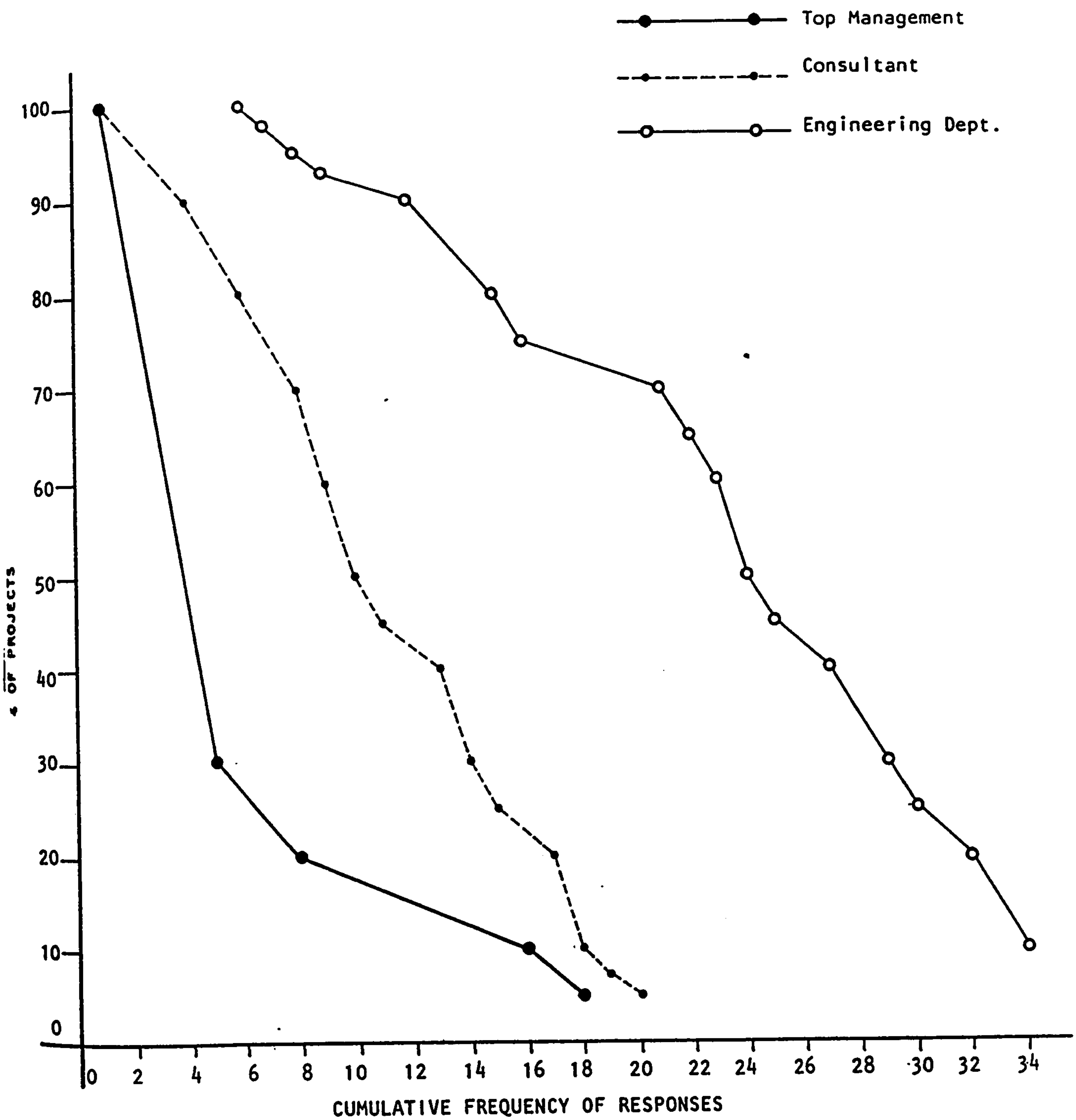

Figure 4.1. Top management, engineering departments, and consultants involvements in setting CCD.

The variation of the three parties involvement in setting CCD from Authority to Authority could be attributed to several factors:

- Management style: In certralized organizations, it is expected that CCD is set by top management. Decentralized organizations may delegate the authority of setting CCD to engineering departments.
- Nature of projects executed by the concerned authority, i.e. project value, importance, urgency and so on. In case of extremely important projects, top management is expected to set CCD, since it is at that level of responsibility where the importance and sensitivity of a project is first known.
- Qualifications of the engineering departments determine the ability of these departments to estimate a reasonable CCD. If these departments are not qualified enough, Agencies may rely on consultant services to estimate CCD or top management may take the responsibility of making the decision.
- Availability of funds to hire consultants determines the possibility of using their services to design projects and consequently determine CCD.

4.2.1.2 Methods of Setting CCD

The second part of the first question requested respondents to explain the methods applied at their departments to set CCD. Excluding the three respondents who reported that they do not know how CCD is set (see 4.2.1.1), 40 out of 43 respondents commented on the methods or procedures followed to set CCD in their departments. Their comments were analyzed and grouped into seven categories.

1. "Budget allocations" were reported to govern the setting of CCD by 30% of respondents. This issue will be discussed later in this subsection.
2. "Urgency or the need for the project" establish the basis for setting CCD. This statement was reported by about 18% of respondents. Two of these respondents mentioned "a target completion date requested by top authorities". No specific information was given.
3. Past experience obtained from finished projects is the basis usually used to determine CCD, reported approximately 13% of the respondents.
4. Critical Path Method (CPM) was reported to be applied to estimate CCD by about 8% of respondents. The same number of respondents stated "CCD is set by joint work of the engineering department and a consultant." No further details were given.
5. Contractors are requested to submit CCD with their bids. This method was reported to be applied by about 6% of the respondents.
6. Other respondents mentioned, cost, "technical study", "according to higher instructions" and other statements, with no further

details given on any existing procedures or methods followed in the determination process.

7. One respondent reported what seems to be a guideline to set CCD, he said:

"The design department sets CCD for projects of less than SR 15 million, it is then presented to the general director of projects for approval according to his experience. Projects which cost more than SR 15 million are designed by consultants who determine CCD, this is due to the lack of trained engineers".

But no specific information was given on the methods applied to set CCD in the "design department" or those used by consultants.

Examining the respondents' comments on methods applied to set CCD, one can conclude that there seems to be no systematic engineering approach or a formal written procedure adopted by government authorities to set CCD, but rather there are three general patterns of setting CCD. These patterns can be described in the following three cases:

Case (1): CCD by environmental constraints:

a) Financial (budget)

b) The need for the project

Case (2): CCD by owner

a) Subjective criteria: experience for instance.

b) Objective criteria: CPM, cost, etc.

Case (3): CCD by other parties

a) Consultants

b) Contractors

The respondents' comments indicate that budget allocation constraints seem to be one of the most important factors affecting the decision on CCD.

In order to understand this problem, the system of funding public construction projects has to be reviewed. Funds are allocated to public construction projects through a budget project number and a budget project name. For each project number (and name) two figures appear in the annual budget of any Governmental Agency (project owner). The first figure represents the total funds allocated for that specific project. The second figure represents the current fiscal year's appropriation which is the maximum amount of money to be spent on a certain project during that fiscal year. This fact, in many cases, dominates the decision on CCD. For example: Project A has total allocated funds of SR 50 million and SR 15 million allocated for the current fiscal year in which the project is to be sent for tendering. Consequently, for this project CCD cannot be one year, two years CCD does not seem adequate either. CCD may be between three to four years. This fact - with consideration to the current tight national economic situation - explains the high frequency the term "budget allocation" was reported by respondents.

The second pattern in Case (1) is "the need" which is a general term including all city or society needs that necessitate a specific completion date. Respondents did not report any specific need or reason for a target completion date. It seems that this is performed at higher levels of responsibility.

In Case (2) (CCD by owner) respondents, in most of the cases, were stating what seems to be their own explanation of applied practice rather than referring to a written method or a formal procedure. The following are quotations of the respondents' comments on this issue. One respondent wrote "CCD is determined by the engineers who designed the project and prepared its quantities and specifications, this is in the case of projects designed in house". Another respondent listed the following criteria:

" 1. according to project type, i.e., roads, buildings etc.
2. understanding the factors affecting the execution.
3. past experience of finished projects.
4. according to budget allocation constraints."

A third respondent reported "The design engineer study the project and CCD depends on project's value, site, and nature".

The remainder of the responses do not differ greatly. As can be seen, respondents were describing factors affecting CCD or constraints to the setting process rather than methods of setting CCD. This fact provides further support to the original hypothesis that Government Authorities follow no specific engineering methods to set CCD.

In Case (3) (CCD by other parties), the consultants who design the construction project seem to submit proposed CCD along with the design. No specific information was given by respondents about the methods applied by consultants to determine CCD, neither were there any comments on the approval procedure of CCD submitted by a consultant.

Three respondents reported that CCD is proposed by contractors but again there was no additional information about what happened afterward, i.e. are there any guidelines regarding CCD provided with tender documents is the CCD proposed by the selected contractor taken as is is the lowest price bid selected regardless of CCD?. The researcher contacted (by phone) one of these respondents who reported that CCD is submitted by contractors. He stated "we establish a duration range and then the project is sent for tendering, the best offer (in terms of price) within the time range is selected". An evaluation of the practice of setting CCD by contractors is discussed in Subsection 4.2.3.4.

4.2.1.3 Attention Paid to Setting CCD

After surveying the current practice of setting CCD, respondents' opinions towards the consideration given to the setting of CCD were collected - do respondents think that the setting of CCD receives enough attention at their departments in all projects or in some ? Question number three of the questionnaire addressed this issue giving respondents a range of five choices ranging from "enough attention in all projects" to "no attention at all".

Forty-five respondents participated and their responses are summarized as follows:

- forty-four percent of respondents stated that setting CCD receives enough attention in all projects at their departments;
- forty-one percent of them said it receives enough attention in most of their projects;
- thirteen percent reported it receives enough attention in only some of their projects; and
- only two percent thought that setting CCD does not receive enough attention at any of their projects.

These results show that the majority of respondents (84%) think that the setting of CCD is given high consideration. The mean response is 4.24 on 1-5 scale with standard deviation of 0.86 meaning that the average evaluation of the attention is little more than "enough attention in most of the projects". The opinions do not seem to be affected by the absence of a formal procedure or a systematic engineering approach to set CCD which was the conclusion of the analysis presented in Section 4.2.1.2. This means that respondents believe that the setting of CCD receives enough attention while there seems to be no formal approach used in the setting process. No significant correlation was found between respondents' evaluation of the attention paid to set CCD and their experience ($r = -0.05$). Test of independence was also performed to see whether respondents evaluation of this issue is independent of their positions or not. A Chi-square value of 8.196 was obtained which implied accepting a probability of .224 of being wrong if the null hypothesis of independence is rejected. This is a very high probability, thus we fail to reject the null hypothesis. The conclusion is that respondents' evaluation is independent of the positions they occupy. This issue will be further discussed in Subsection 4.2.3.1.

4.2.1.4 Adequacy of Set CCD

A hypothesis made at the research design stage is that severe time limits are placed on contractors, i.e. CCD is short. Respondents were asked to evaluate the CCD set in their departments by Question 7 of the survey. This question requested information about the adequacy of set CCD, i.e. is it very short, short, reasonable, long, or very long, and what percentage of projects fall into each category.

The results of the respondents' evaluation of CCD as being very short, short, reasonable, or long are presented in detail in Tables 4.4 to 4.7. Table 4.8 summarizes these former tables by considering only the frequency of the responses in each of the five categories of CCD evaluation. When the percentages of projects are considered as a weighing factor to the evaluation, the respondents' evaluation of the adequacy of CCD is depicted in Figure 4.2. An examination of Tables 4.4 to 4.8 and Figure 4.1 clearly suggests that the assessment of CCD as being reasonable dominates respondents' opinions. These results do not support the original hypothesis stated above (CCD is short).

TABLE 4.4. Frequency & Percentage of Very Short CCD.

% of projects in which CCD is Very Short	Frequency No. of respondents
5	1
15	1

TABLE 4.5. Frequency & Percentage of Short CCD.

% of projects in which CCD is Short	Frequency No. of respondents
5	2
10	5
15	3
20	2
30	1
35	1
50	1

TABLE 4.6. Frequency & Percentage of Reasonable CCD.

% of projects in which CCD is Reasonable	Frequency No. of respondents
40	1
50	1
60	1
65	1
70	5
80	15
85	2
90	8
95	2
96	1
100	2

TABLE 4.7. Frequency & Percentage of Long CCD.

% of projects in which CCD is Long	Frequency No. of respondents
5	3
10	4
15	4
20	1
20	2

TABLE 4.8. Adequacy of Set CCD.

Category	Percentage of responses	Frequency No. of responses
Very short	3	2
Short	21	15
Reasonable	56	39
Long	20	14
Very long	0	0

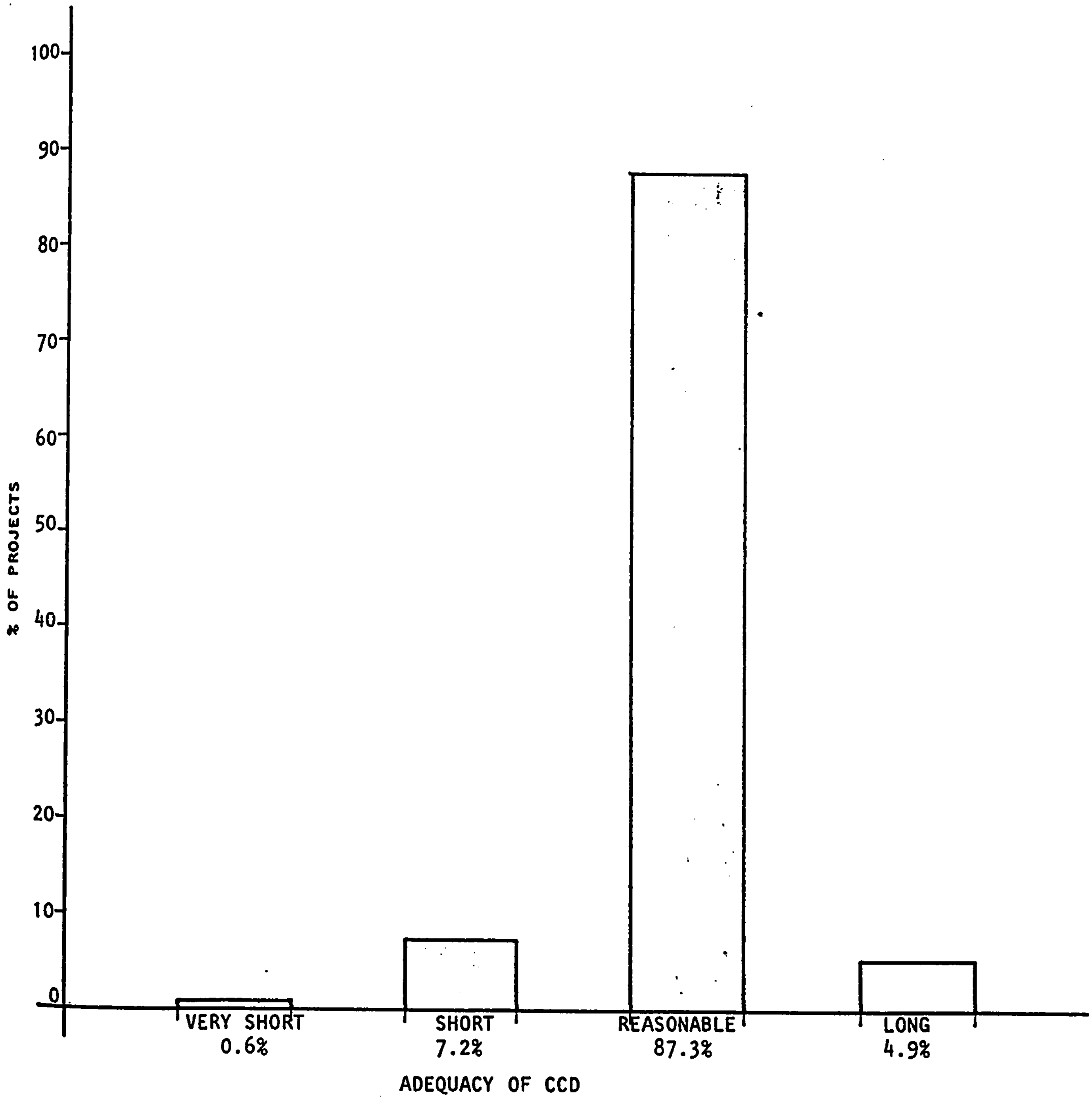

Figure 4.2. Adequancy of set CCD.

Actual performance of constructed projects was also surveyed by means of a table attached to the questionnaire. The table collected information about five finished projects in each department. Thirty respondents completed the table with 145 projects. These projects were distributed evenly in the periods they were finished (from 1980 to 1989). This distribution was guided by the design of the table (see Section 3.4.1.6). These projects were diversified in cost (ranging from SR 1.00 million to SR 100 million), in CCD (ranging from 1 month to 49 months), and in type (roads, buildings, sewage and water, electromechanical and several others).

The results of this survey are summarized as follows:

- approximately 70% of the projects (101 out of the 145) experienced time overruns;
- in about 63% of the above delay events (64 out of 101), the contractor requested a time-extension; and,
- in about 84% of the cases of time extension request (54 out of 64), the time extension was given.

Relating these statistics to the issue of CCD adequacy, the last statistics concerning the granted time extensions is of most relevance. Several possibilities could exist when a project owner grants time-extension to a contractor. Possibilities include

- a change order was issued concerning a change in quantities or design of work,
- unforeseen problems were encountered or "act of God" has happened, and
- CCD was originally unreasonably underestimated.

The results of the time performance table revealed that, out of the 145 finished projects, 54 projects (about 37%) experienced time over-runs where the contractors have been given extra time. Although it cannot be stated unequivocally, a possibility exists that the tendency for the Government to grant time extensions is caused - at least partially - by the originally underestimated CCD. This interpretation provides some support to the hypothesis that severe time limitations are placed on contractors.

4.2.2 Consequences of Setting Short/Long CCD

Questions 5, 6, 8, and 9 of the questionnaire list negative and positive consequences of short and long CCD. Respondents were asked to evaluate these consequences using a range consisting of five levels of negativity/positivity. An average of 45 respondents participated in the evaluation of these consequences. The questions provided space for respondents to add any other consequence(s) not included in the list. The next two sections present those consequences.

4.2.2.1 Consequences of Short CCD

The questionnaire contained seven negative consequences and three positive consequences of short CCD. Tables 4.9 and 4.11 list the consequences of short CCD in a descending order of negativity/positivity as assessed by respondents. Evaluation ranges from 5 (extremely negative/positive) to 1 (not negative/positive). Respondents evaluated poor performance resulting from inadequate time allocations to work items by contractors as the most negative consequence of short CCD. This engineering problem of short CCD was followed in negativity by a managerial problem, i.e. the excessive administrative burden resulting from delay claims. The most positive consequence of short CCD, as evaluated by respondents, is raising contractor's awareness of the importance of time.

Examination of Tables 4.9 and 4.11 shows that respondents expressed stronger attitudes towards negative consequences than positive consequences of short CCD. Six out of the listed seven negative consequences had higher mean response than the highest mean response for the positive consequences. This suggests that respondents felt that the disadvantages of short CCD outweigh its advantages. Nine respondents added to the lists of negative and positive consequences of short CCD. These respondents mentioned that short CCD makes it difficult to issue change orders, another two stated that short CCD has "damaging effects on contractors." No specific explanation of these damages were given. Positive consequences of short CCD added by respondents include fast project use (suggested by 12 respondents) and best utilization of budget allocations (suggested by two respondents). All negative and positive consequences of short CCD added by respondents are listed in Tables 4.10 and 4.12 in a descending order of the frequency they were mentioned by respondents.

It can be seen from Tables 4.10 and 4.12 that, except for "fast project use", the consequences of short CCD originally listed in the questionnaire are relatively comprehensive.

4.2.2.2 Consequences of Long CCD

The same approach applied to survey consequences of short CCD was applied to survey consequences of long CCD. The questionnaire listed three negative and three positive consequences of long CCD. Tables 4.13 and 4.15 list negative and positive consequences of long CCD ranked in a descending order of negativity/positivity as assessed by respondents. Evaluation ranges from 5 (extremely negative/positive) to 1 (not negative/positive).

Tables 4.13 and 4.15 show that respondents expressed stronger attitudes towards negative consequences more than positive consequences which is the same conclusion drawn from respondents' assessment of consequences of short CCD. However, examination of Tables 4.9, 4.11, 4.13, and 4.15, shows that the attitudes of respondents towards the negative consequences of long CCD are not as strong as towards negative consequences of short CCD, while their attitudes towards positive consequences of long

CCD are stronger than towards positive consequences of short CCD. This result suggests that respondents felt that a long CCD is, in general, less damaging and more advantageous than a short CCD.

Eighteen respondents contributed to the list of negative consequences of long CCD and 14 respondents contributed to the list of positive consequences of long CCD. These added consequences are found in Tables 4.14 and 4.16 in descending orders of the frequency they were mentioned by the respondents. The original lists of consequences of long CCD are not as comprehensive as those of short CCD. Two negative consequences and two positive consequences were added by a high number of respondents as can be seen from Tables 4.14 and 4.16. These include delaying project utilization, increase in supervision costs, helps to cover budget deficits and makes design revisions/changes possible.

TABLE 4.9. Negative Consequences of Short CCD (Originally listed in the Questionnaire).

Consequence	Mean Response (a)	Standard Deviation	Rank
Poor performance by contractors resulting from inadequate time allocation to work items	4.00	1.16	1
Excessive administrative burden resulting from delay claims	3.89	1.03	2
High bid prices	3.82	1.28	3
Coordination difficulties	3.17	1.18	4
Disruption of budget planning	3.05	1.16	5
Contractor's unwillingness to bid, because they know the project cannot be done in the specified time	2.97	1.15	6
Supervision difficulties	2.39	1.19	7

(a) Ranges from 5 (extremely negative) to 1 (not negative)

TABLE 4.10. Negative Consequences of Short CCD (Added by Respondents).

Consequence	Frequency (a)
Difficulties in issuing change orders	2
Have damaging effect on contractors	2
Contractor's carelessness beyond the completion due date since liquidated damages maximum is reached	2
High potential for disputes	1
Difficult to manage	1
Too much subcontracting	1
Economically unfeasible	1

(a) Number of respondents who mentioned a consequence

TABLE 4.11. Positive Consequences of Short CCD.

(Originally listed in the Questionnaire)

Consequence	Mean Response (a)	Standard Deviation	Rank
Raising contractor's awareness of the importance of time	2.85	1.42	1
Promoting Effective management	2.38	1.28	2
Low prices due to short CCD	1.72	1.06	3

(a) Ranges from 5 (extremely positive) to 1 (not positive)

TABLE 4.12. Positive Consequences of Short CCD.

(Added by Respondents)

Consequence	Frequency (a)
Fast project use	12
Best utilization of budget allocations	2
Less coordination efforts needed	1
Less design changes	1
Weaving unqualified contractors	1
Saving supervision time to other projects	1

(a) Number of respondents who mentioned a consequence

TABLE 4.13. Negative Consequences of Long CCD.

(Originally listed in the Questionnaire)

Consequence	Mean Response (a)	Standard Deviation	Rank
Encouraging contractors to bid more work than can be handled in a timely manner	3.59	1.06	1
Discouraging effective management and innovation	3.21	1.22	2
Leading to poor performance resulting from discontinuous operations (relaxed schedule)	2.61	1.23	3

(a) Ranges from 5 (extremely negative) to 1 (not negative)

TABLE 4.14. Negative Consequences of Long CCD.
(Added by Respondents)

Consequence	Frequency (a)
Delaying project utilization	13
Increase in supervision costs	6
Increase in cost	2
Delaying other dependent projects	1
Contractor's relaxation in execution	1
Contractor's high potential for losses	1

(a) Number of respondents who mentioned a consequence

TABLE 4.15. Positive Consequences of Long CCD

(Originally listed in the Questionnaire).

Consequence	Mean Response (a)	Standard Deviation	Rank
Good coordination with other agencies	3.27	1.08	1
Permitting more contractors to bid	2.75	1.30	2
Low bid prices	2.47	1.16	3

(a) Ranges from 5 (extremely positive) to 1 (not positive)

TABLE 4.16. Positive Consequences of Long CCD.
(Added by Respondents)

Consequence	Frequency (a)
Helps to cover budget deficits	8
Makes design revisions/changes possible	4
Improve quality control	3
Flexibility in change orders especially extra quantities change order	1
Enough time for importing materials	1
Enough time for preparation for operation	1

(a) Number of respondents who mentioned a consequence

4.2.3 Alternative Approaches to Setting CCD

The last two sections (4.2.1 & 4.2.2) presented the current practice applied to set CCD and the consequences of the set CCD. This section presents the alternative approaches to the current practice. It starts by measuring the need for alternative approaches followed by identifying these factors affecting the setting of CCD. Then respondents' opinions towards responsible agency for setting CCD is presented. After that, the practice of setting CCD by contractors is assessed. Finally respondents' ideas and recommendations related to the setting of CCD are presented.

4.2.3.1 The Need for a Method to Set CCD

The importance of applying a systematic engineering method to set CCD is evaluated in Question 4 of the questionnaire. Five degrees of importance ranging from 5 (extremely important) to 1 (not important) are listed for the choice of respondents. Forty-six respondents participated in the evaluation. The results are summarized in the following statistics.

- Forty-four percent of respondents reported it is "extremely important" to apply a systematic engineering method to set CCD.
- Twenty-six percent think it is "very important".
- Seventeen percent think it is "important".
- Eleven percent think it is "somewhat important".
- Two percent think it is "not important".

As the above statistics suggest, the majority of respondents (87%) expressed the need to apply a method to set CCD.

The mean response to the above question is 3.98 which is approximately at "very important" level (standard deviation of 1.13). A correlation analysis between respondents' experience and their evaluation of the need to apply a systematic engineering method to set CCD yielded a correlation coefficient $r = 0.4$, Prob. _ .05. This result may suggest that as the respondents' experience increases their realization of the need to use a method to set CCD increases, which provides support to the recommendation of developing a method. To investigate a possible relation between the respondents' attitudes toward the need of applying a systematic method to set CCD and their positions, the two sets of data were cross tabulated (Table 4.17) and a Chi-square test was performed.

The test yielded a Chi-square value of 8.882 which implies accepting a probability of 0.448 of being wrong if the null hypothesis of independence between the two variables of concern is rejected. The probability is too high to be accepted; thus, the conclusion is that respondents' evaluations of the importance of applying engineering methods to set CCD seem to be independent of the positions they occupy.

Results of this subsection and the results of Subsections 4.2.1.2 and 4.2.1.3 suggest the following three conclusions:

TABLE 4.17. Cross tabulation of Respondentss' Position and Their Evaluation of the Importance of Applying Engineering Methods to Set CCD (a).

Respondents' Position	Importance of Applying Engineering Methods to Set CCD			
	Somewhat Important	Important	Very Important	Extremely Important
Construction Engineer	0 0.00	0 0.00	0 0.00	1 4.00
Design Engineer	0 0.00	1 4.00	0 0.00	0 0.00
Director of Engineering Department	3 12.00	3 12.00	4 16.00	9 36.00
General Director	0 0.00	0 0.00	2 8.00	2 8.00
TOTAL	3	4	6 24.00	12 48.00

FREQUENCY MISSING = 4

(a) In each cell, the top figure is the frequency and the lower figure is the percentage.

- no systematic engineering methods seem to be applied to set CCD;
- respondents realize the importance of applying a systematic and clear method; and
- despite the above two conclusions, respondents still think that the setting of CCD receives enough attention.

To resolve what seems to be a contradiction in the above conclusions, two interpretations are suggested. First, the phrase "Paying enough attention" has several dimensions:

- time spent discussing CCD among concerned engineers,
- levels of authorities required to set CCD, and
- levels of coordination between various departments.

Accordingly, respondents could be evaluating the attention paid to set CCD based on one of the above criteria.

The second interpretation centers on a "self-defense" bias since most of the respondents who evaluated the attention paid to set CCD are actually those who set it. This is known from the results of Questions 1 and 15 (see Subsection 4.2.1.1 and the introduction to Section 4.2). Therefore, it is not expected that respondents will report that setting CCD does not receive enough attention while they (themselves) are responsible for the setting.

4.2.3.2 Factors Affecting the Setting of CCD

This study originally identified eight factors deemed to affect the setting of CCD. Question 2 of the questionnaire asked the respondents to assess the importance of these factors utilizing a five-point Likert scale ranging from 1 (not important) to 5 (extremely important). Table 4.18 lists these factors in a descending order of importance according to the arithmetic mean response. Some of the respondents (20 out of the 47) contributed to the original list of factors as shown in Table 4.19.

Examination of Tables 4.18 and 4.19 indicates that the factors affecting CCD can be grouped into three main categories: project characteristics, contractor characteristics, and environmental characteristics.

Project Characteristics include all factors attributed to the project itself. Project size, which belongs to this category, was ranked first by respondents. This is a natural result since project size is a general term describing the area the project will occupy and the amount of materials and equipment to be used in the construction. Project design was ranked third. The complexity of the project design is a major factor determining the time needed for preparing shop drawings and constructing the project. Among other important factors in this category are project type (roads, buildings, electromechanical, etc.) and project estimated cost. Respondents also added, as can be seen in Table 4.19, other factors which belong to this category, i.e. mobilization period and type of construction materials.

TABLE 4.18. Factors Affecting the Setting of CCD.

(Originally listed in the Questionnaire)

Factor	Mean Response (a)	Standard Deviation	Rank
Project size	4.60	.61	1
Site conditions	3.72	1.04	2
Project Design	3.71	.78	3
Top management assessment of the city need of the project	3.33	1.33	4
Project type	3.29	1.13	5
Project estimated cost	3.22	1.30	6
Expected qualifications of prospective bidders	2.77	1.34	7
Weather	2.11	0.91	8

(a) Ranges from 5 (extremely important) to 1 (not important)

TABLE 4.19. Factors Affecting the Setting of CCD.

(Added by Respondents)

Factor	Frequency No. of Respondents
Budget allocations	8
Availability of materials	5
Availability of supervision staff	4
Inter-relation of the project with other projects	4
Relocation of utilities	2
Mobilization period	2
Coordination with other parties	2
Types of construction materials	1
Technology used	1
Feasibility of finishing the project	1

Most of these factors are well explained by the project tender documents which contain the plans and specifications, bills of quantities, general and special conditions, and the agreement. A detailed study of the tender documents of a construction project is the basic step in determining CCD for that project.

Contractor characteristics are the second major group of factors affecting CCD. The resources available to a contractor (finance, qualified staff, equipments, etc.), degree of technology he uses, and his experience in executing similar projects are basic factors affecting the time he needs to construct a project. The expected qualifications of prospective bidders are very important factors affecting CCD and should be taken into consideration in any method or procedure adopted to determine CCD.

The category environmental characteristics includes all factors affecting CCD which cannot be attributed to the project or to the contractor. Site conditions are the major factor in this category. The term "site conditions" is generally used to describe the topography, the soil conditions, the availability of facilities at the construction site, and the ease of access to the site. This explains the respondents' evaluation of "site conditions" between "important" and "very important" with a mean response of 3.72 which is closer to "very important." Site conditions are, sometimes, explained by the tender documents of the project and in other cases it is left to the contractor to investigate. Accordingly, some of the implications of this factor are included in the first category, project characteristics. Another important factor in this category is top management assessment of the city need of the project. In many cases, as reported by respondents in answers to Question 1, this assessment establishes a specific completion date the project should meet. Respondents added factors other than those originally listed in the questionnaire. Eight respondents mentioned "budget allocations" as a very important factor affecting CCD. This issue was discussed in Subsection 4.2.1.2. Coordination with other parties to secure work permits, relocate utilities in the site, and to plan the interfacing of the project with other projects are examples of important factors affecting CCD.

Setting CCD needs an integrated look into the above categories of factors. These factors should be incorporated in any method developed to determine CCD. If CCD is determined based on only the project characteristics, for example, CCD is expected to be underestimated.

4.2.3.3 Responsible Agency for Setting CCD

It was shown in Subsection 4.2.1.1 that, based on respondents' reports, CCD is currently set by either top management of the Government Agency (project owner), engineering department, or by hired consultants. Respondents' opinions towards who should be responsible for setting CCD were surveyed in Question 10. Forty-six respondents participated in this question and approximately half of them thought that CCD should be set by a joint effort of top management, engineering department and consultants. The pie chart (Figure 4.1) shows the results.

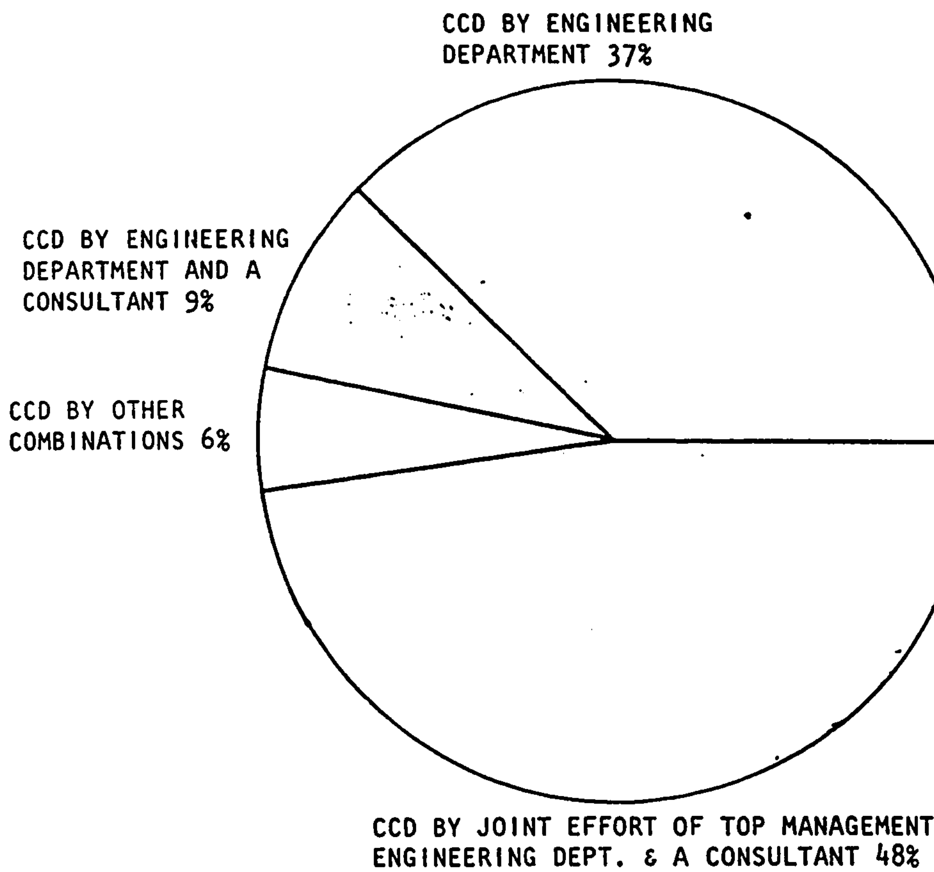

Figure 4.3. Respondents opinions towards responsible agency for setting CCD.

It seems that respondents are almost in agreement that the engineering department of the Government Agency (project owner) should always take part on the determination of CCD. This is a natural result since the engineering departments are expected to know the most about CCD and factors affecting its determination. Another reason which might explain the agreement is that 54% of respondents are directors of engineering departments and another 14% of them are working in engineering departments as design or construction engineers.

4.2.3.4 Setting CCD By Contractors

The method of setting CCD by contractors was explored in Question 13 of the questionnaire. In this method, projects not needed to be finished at a specific date are sent for tendering with a preliminary CCD suggested by the owner. Contractors are then to estimate CCD and submit it with their bids.

Forty-five respondents participated in the evaluation of the above practice. They were to select among four possible choices (see Subsection 3.4.1.4). Following is a summary of the results

- Approximately 49% of respondents thought that the method is <u>not suitable</u> since it will make the task of the bid inspection committee difficult.
- About 22% of respondents thought that the method is <u>suitable</u> and applicable to <u>most</u> projects.

- About 11% of respondents thought that the method is very suitable and applicable to all projects since it will result in low bid prices and avoidance of negative consequences of time over-runs.
- About 9% of respondents thought that it is possible to apply the practice but only in some projects.
- The remaining 9% of respondents did not select any one of the four choices listed above and preferred to write their own comments in the space provided. Unfortunately the comments of these four respondents did not address the issue of setting CCD by contractors; rather, they commented on other methods of setting CCD. For example, one respondent wrote "It is better to set CCD by joint efforts of engineering departments and consultants." The other three wrote similar comments. These four respondents could be considered not favoring this practice.

As far as assessing the practice of setting CCD by contractors, respondents could be clsssified into disfavoring and favoring groups.

The disfavoring group includes 60% of respondents (26 out of 45). Unfortunately, 23 of these respondents did not support their opinions with written justifications. They seem to find the justification originally written in the questionnaire - making the task of the bid inspection committee difficult - enough for their disfavoring the practice. The other three respondents wrote more reservations on the practice. Two of them stated that contractors may submit short CCD with their bids to get the project, then they experience delay. The third respondent said "Competition may increase to a degree affecting the project negatively" which is more or less related to the previous statement.

The favoring group includes 40% of respondents (19 out of 45). Fifty-eight percent of the respondents of this group (11 out of 19) stated conditions for their recommendation of the practice. These conditions are listed below.

1. Request contractors to submit schedules with their bids.
2. Request contractors to submit qualifications of technical staff proposed to work in the project.
3. The lowest bid or shortest CCD should not be the governing factor in awarding projects.
4. The liquidated damages maximum should be revised (increased) since CCD is set by contractors.
5. Consider budget allocations constraints.
6. No negotiations with bidders regarding CCD after bid opening.
7. Use for projects where owners cannot determine reasonable CCD.
8. Do not let contractors submit "any time", give guidelines (range) or a maximum CCD.
9. Assign highly qualified personnel to be members of the bid inspection committee.
10. Consider the interests of project users.

Respondents who favour the practice also commented that care must be exercised before requesting contractors to set CCD. This is to minimize the administrative problems arising from multiple CCD bids and to make sure that projects do not suffer negatively from contract's overcompetition, i.e. offering short CCD to get the project and then experience delay.

The practice of setting CCD by contractors is obviously recommended only when no specific completion date is required. This practice is very much expected to minimize project's cost since contractors are allowed to schedule the execution at least cost. In conclusion, applying the practice of setting CCD by contractors depends on the objectives of the project owner and the constraints governing CCD.

4.2.3.5 Other Approaches

To identify other approaches to setting CCD, respondents were asked the open ended question "What method do you consider the best for considering CCD?" Forty-three respondents contributed by either listing factors affecting CCD (essentially repeating what they have said in Section 4.2.3.2), suggesting the use of a certain procedure, or stressing the importance of developing a method for determining CCD. An example of responses to this question include "Use the experience gained from similar projects in determining actual time and check construction time with the nature of the project, its circumstances, and the urgent need for it". Another stated "The concerned department should study the quantity of each work items and determine time to execute it and the interdependency between work items".

Respondents' ideas were examined and summarized as follows:

- thirteen respondents suggested using CPM or any other scheduling technique to estimate CCD;
- eleven respondents reported "Budget allocations constraints should be considered before any decision on CCD.";
- ten respondents thought that past experience of finished projects is a very important input to the determination process; and,
- four respondents suggested the development of a method to determine CCD. One of these respondents stated that a mathematical model may be developed to estimate CCD.

END NOTES

Test of Independence

The test of independence between two variables in a contingency table has been studied by many researchers. In 1900 Karl Pearson suggested the statistic:

$$X^2 = \sum_i \sum_j \frac{(n_{ij} - m_{ij})^2}{m_{ij}}$$

for testing the null hypothesis H_0: independence. In this formula n_{ij} and m_{ij} are the observed and expected frequencies of the contingency table categories in row i and column j respectively. When H_0: independence is true, X^2 has asymptotic chi-squared distribution with degrees of freedom df = (r-1)(c-1), r is number of rows and c is number of columns (Agresti, 1984). When applying the Chi-squared test, attention should be paid to the expected or observed cell frequencies in the contingency tables, since when these frequencies are small, the validity of the Chi-squared test is questioned. The problem of small cell frequencies is faced almost in every contingency table constructed in this research. This is due to the high number of categories for the responses to a given question, coupled with the relatively small population of the survey (approximately 70 members). Respondents totaled 47 and some of the data were also missing. The validity of the Chi-squared test in situations where expected or observed cell frequencies are small has been the subject of thorough discussions. The following two quotations are cited from a book and newly published research:

> "Various guidelines have been given for how large the sample size should be in order for the Chi-squared distribution to give a good approximation for the exact sampling distribution of X^2 and G^2 statistics. A commonly quoted guideline due to Cochran (1954) is that at least 80 percent of the cells should have m_{ij} exceeding 5.0, and m_{ij} should exceed 1.0 in all cells. Larntz (1978) and Koehler and Larntz (1980) showed that the Chi-squared approximation can be very good for the X^2 statistic even for very small expected frequencies" (Agresti, 1984, p. 10).

Khan (1988) in his paper "Small Sample Comparison of X^2, B, G and FT Goodness of Fit Test" concluded that "X^2 gives a better Chi-squared approximation than does B, G, and FT for small cell expectations such as 1".

Some researchers suggest combining columns or rows in contingency tables in which expected frequencies are small to insure the validity of the Chi-squared test.

"When a frequency is less than 5, the best remedy is to note the row or column (whichever has smaller frequencies) in which the small frequency occurs and to combine that array (row or column) with one of its neighbors. Choosing the neighbor that also has smaller frequencies would be a good policy, but other common sense considerations should also be given some weight" (Guilford and Fruchter, 1978, p. 206).

In the case of 2x2 tables the problem of small cell frequencies is overcomed by using the exact test known as 'Fisher's exact test' (Agresti, 1984) to test the null hypothesis of independence.

As far as this research is concerned, and for the purpose of testing the null hypothesis of independence between two variables in a contingency table, the following policy was adopted.

1. Use the X^2 statistic to test for independence assuming it has a Chi-squared distribution when H_0: independence is true.
2. In contingency tables where expected frequencies are small ($m_{ij} < 5$), two cases exist:
   1- for 2x2 tables, use Fisher's exact test, and
   2- for other than 2x2 tables, combine categories to increase the number of expected frequencies, if not possible the Chi-squared test will be assumed valid even for very small expected cell frequencies based on the citation above.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In this chapter a summary of this study is first presented followed by the major conclusions drawn from the research results. Finally recommendations based on the analysis of the results will be presented.

5.1 SUMMARY

Chapter 1 addressed the importance of time in construction and introduced the Saudi construction environment from two perspectives. Public spending on construction in which total Government expenditures on construction projects during the last three development plans is the first perspective presented. The second perspective is the laws and regulations related to public construction. It was shown that current Government Procurement Regulations do not address the issue of time before signing the contract but only afterwards, when time becomes the subject of tight control.

In the second chapter the literature related to the research subject was reviewed in three parts. The first part dealt with cost-time relationship, the second part discussed the setting of CCD, and the third part addressed the CCD specifications.

The research methodology was presented in the third chapter by first stating the research problem, identifying objectives of the study, and establishing the scope and limitations. The main part of Chapter 3 was devoted to the research design in which the questionnaire structure was explained. The questionnaire contained 18 questions related to seven issues: current practice, factors affecting CCD, consequences of short and long CCD, contractors' participation on setting CCD, personal information, time performance table and, finally, the general comments question. The pilot study which was performed prior to the final production of the questionnaire was presented. The population of the study which consists of 70 Government Agencies was then listed and the data collection mechanism was illustrated.

Chapter 4 presented and discussed the results of the study which were generated from 47 returned questionnaires. Statistical techniques used in the analysis of the data were introduced first. The results were presented under three main issues: current practice, consequences of short and long CCD, and alternative approaches to setting CCD.

Results supported the hypothesis made at the research design stage that there is no systematic engineering methods used by Government Authorities to set CCD. Three patterns seem to exist as far as setting CCD is concerned. These are CCD by environmental constraints (budget allocations, certain needs, etc), CCD by owner, and CCD by other parties (consultants & contractors). Top management, engineering departments, and hired consultants are the three parties currently involved in setting CCD. The practice of setting CCD by contractors found the support of only 40% of respondents. The other 60% thought that it will make the task of contractor selection difficult. There seems to be a consensus among all respondents that the engineering department should always take part in setting CCD.

5.2 CONCLUSIONS

The following findings and conclusions are based on the analysis of the data collected from the survey.

1. There seems to be no systematic engineering methods or, at least, formal procedures followed by Government Authorities to set CCD for public projects.
2. CCD is currently set by engineering departments, hired consultants, or top management of the government agencies. These parties are ordered in a descending level of participation. Engineering departments were reported by 34 respondents (out of 43 responses) to set CCD for a mean percentage of about 67% of the projects. Consultants were reported by 20 respondents to set CCD for a mean percentage of about 51% of the projects. Top management was reported by 18 respondents to set CCD for a mean percentage of about 21% of the projects.
3. Several factors affect setting CCD. Among the most important factors are project size, design, budget allocations, type, and site conditions. These and other related factors could be

grouped into three main categories: project characteristics, contractor's characteristics, and environmental characteristics.

4. There is a strong need for engineering methods to be used to set CCD. These methods should incorporate all factors affecting CCD.

5. The practice of setting CCD by contractors should be used with care. It is expected that multiple CCD bids will make bid evaluation by the bid inspection committee difficult. Guidelines must be established to help the committee select the best offer in terms of price and time.

5.3 RECOMMENDATIONS

5.3.1 General Recommendations

1. The Government Procurement Regulations should address the setting of CCD. Articles have to be written to establish guidelines to improve the current practice of setting CCD.

2. Engineering methods should be developed and used to set CCD. Concerned Government Authorities such as Ministry of Housing and Public Works, Ministry of Municipal and Rural Affairs, and the Ministry of Communications are urged to take the initiative of developing such methods. Recommended guidelines are offered in the following section.

3. The engineering departments of concerned Authorities should participate in the setting of CCD. This is accomplished by either coordination with top management or using the expertise of a hired consultant.
4. CCD should be considered in the budget allocation process.
5. A review of the budget allocations must be performed before setting CCD. This is to insure that the set CCD is compatible with these allocations.

5.3.2 Recommended Guidelines to Set CCD

Based on the results of the study and the conclusions drawn, the following guidelines are suggested to be followed by engineering departments of public project owners in setting CCD. The flow-chart, Figure 5.1, is a graphical depiction of these guidelines.

Step 1: Determine a CCD range.

The inputs to the determination process consist of the following items:

A. The project's tender documents

B. The factors affecting CCD which were addressed in Subsection 4.2.3.2.

C. The uncertainty variables affecting CCD which were addressed in the literature review, Section 2.2. Reference was also made in that section to a model developed to incorporate the effects of these uncertainty variables on CCD.

D. The experience gained from constructed projects.

Using the above inputs and utilizing scheduling techniques (CPM, PERT, Bar Chart, etc.), production rates, or any other approach, a reasonable CCD range can be estimated.

Step 2: Check whether the setting of CCD is under the authority of the project owner. This is to find out if there is any preplanned completion date established by higher authorities to meet special operational or public needs. In such cases the project owner can discuss CCD with decision makers based on the range established in Step 1. The set CCD is to be incorporated in the tender documents.

Step 3: If the project owner is authorized to set CCD, then he can proceed to check whether budget allocation constraints exist or not. When there are budget allocation constraints, the set CCD should comply with these constraints.

Step 4: In the case where there is no budget allocation constraint, the project owner is to identify his objectives of CCD. Three alternative objectives exist:

A. Constructing the project at least possible bid price. When this objective is selected, the recommended policy is to let contractors set CCD within the established range (developed in Step 1 above). Contractors are to be informed that the criterion is least bid price. Contractors in this case are allowed to schedule the construction at least possible cost.

B. Constructing the project at shortest possible CCD. If the project owner selects this objective then he may set CCD at crash time (the lower limit of the range established in Step 1). Alternatively, the project owner may also let contractors set CCD and inform them about the criterion.

C. Set an optimal total cost CCD. This objective is selected when the owner is to tradeoff between time and cost, considering the tangible and nontangible costs associated with the various completion dates.

Step 5: The set CCD, produced by either Steps 3 or 4, should be reported to top management for approval.

Step 6: The approved CCD is to be incorporated in the tender documents.

Step 7: During project construction and after completion, the time performance of the project, factors and uncertainty variables affecting CCD, and applicability of approach used to determine CCD should be documented and incorporated in the inputs discussed in Step 1.

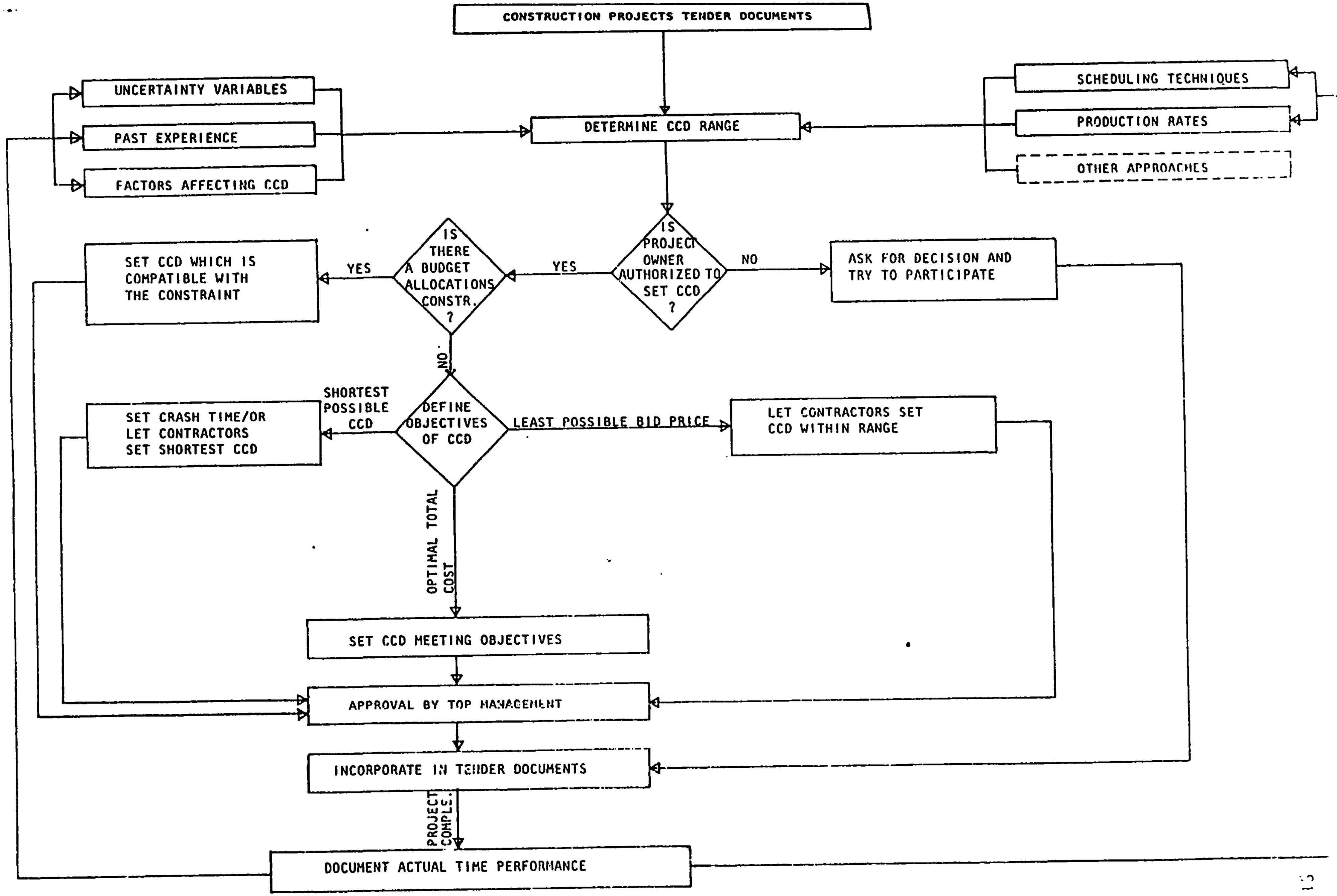
CONSTRUCTION PROJECTS TENDER DOCUMENTS
UNCERTAINTY VARIABLES
PAST EXPERIENCE
FACTORS AFFECTING CCD
DETERMINE CCD RANGE
SCHEDULING TECHNIQUES
PRODUCTION RATES
OTHER APPROACHES
IS PROJECT OWNER AUTHORIZED TO SET CCD ?
NO
ASK FOR DECISION AND TRY TO PARTICIPATE
YES
IS THERE A BUDGET ALLOCATIONS CONSTR. ?
YES
SET CCD WHICH IS COMPATIBLE WITH THE CONSTRAINT
NO
DEFINE OBJECTIVES OF CCD
SHORTEST POSSIBLE CCD
SET CRASH TIME/OR LET CONTRACTORS SET SHORTEST CCD
LEAST POSSIBLE BID PRICE
LET CONTRACTORS SET CCD WITHIN RANGE
OPTIMAL TOTAL COST
SET CCD MEETING OBJECTIVES
APPROVAL BY TOP MANAGEMENT
INCORPORATE IN TENDER DOCUMENTS
PROJECT COMPLE.
DOCUMENT ACTUAL TIME PERFORMANCE

Figure 5.1.

5.3.3 Recommendations for Further Research

1. This study treated the problem of setting CCD from the owner's point of view. Research could be conducted to study other related parties' point of view, e.g., contractors, consultants, or project users.
2. This study dealt with the management side of setting CCD more than the engineering side. Further research could be conducted to study the engineering problems of setting CCD. Engineering methods may be developed to assist responsible engineers to determine a reasonable CCD.
3. Surveys could be performed to assess the attitudes of Government officials towards the guidelines suggested in Subsection 5.3.2.

APPENDIX A

ARABIC VERSION OF THE QUESTIONNAIRE

بسم الله الرحمن الرحيم

جامعة الملك فهد للبترول والمعادن
كلية تصاميم البيئة
برنامج هندسة وإدارة التشييد

إستبيان

عن

الأسلوب المتبع في تحديد مدة تنفيذ مشاريع التشييد في المملكة

بسم الله الرّحمن الرّحيم

سعادة الأخ . . . .

السلام عليكم ورحمة الله وبركاته :

الإستبيان الذي بين يديك يهدف إلى إستطلاع مرئيات مدراء ومهندسي الإدارات الحكومية المعنيه بتنفيذ مشاريع التشييد حول الطرق المناسبة لتحديد مدة تنفيذ هذه المشاريع .

وسوف تستخدم هذه المعلومات لأغراض البحث العلمي فقط ، حيث ستشكل عنصراً رئيسياً في نجاح الباحث للوصول إلى نتائج مفيده وقابلة للتطبيق في موضوع البحث وعنوانه :

« تحديد مدة تنفيذ مشاريع التشييد العامة في المملكة العربية السعودية »

سيأخذ هذا الاستبيان من وقتك الثمين ما بين ١٥ - ٢٥ دقيقة . كما ان الإجابات ستكون موضع السرية وسيتم تحليلها بصورتها الإجمالية .

أشكر لكم سلفاً تعاونكم .

وتقبلوا تحياتنا !!!

الباحث	الأستاذ المشرف
أحمد السلطان	د . سليمان المهوس

« مقدمة »

آمل قراءة هذه الملاحظات قبل تعبئة الإستبيان :

١ - تعريف : المقصود بـ مدة تنفيذ المشاريع هو الوقت المعطى للمقاول فى دفاتر الشروط والمواصفات لتنفيذ المشروع وليس الوقت الذي يستغرقه المقاول فعلاً فى الإنجاز .

أينما وردت كلمة مشاريع فى هذا الإستبيان فهى تعنى مشاريع التشييد .
ولا يشمل هذا الإستبيان مشاريع التشغيل والصيانة التى تحدد مددها بأسلوب مختلف .
المشاريع المشموله بهذا الإستبيان - تتراوح تكاليفها بين مليون ريال ومائة مليون ريال .

٢ - الإجابات : تختلف الأسئلة فى هذا الإستبيان بعضها عن بعض حيث تتطلب الإجابه فى معظم الأحيان وضع علامة ✓ على الإجابة أو الإجابات المناسبة . كما تتطلب بعض الأسئلة تحديد أهمية العنصر المذكور حيث وضعت خمس درجات من الأهمية هى :

مهم للغاية - تعنى أعلى درجة ممكنه من الأهمية لعنصر ما .
مهم جداً - تعنى أن هذا العنصر مهم جداً فى جميع المشاريع
مهم - تعنى أن هذا العنصر مهم ولكن بدرجة أقل من سابقه وفى معظم المشاريع .
مهم أحياناً - تعنى أن العنصر هام فى بعض المشاريع
غير مهم - تعنى أن العنصر غير مهم فى الغالب .

كما أن بعض الأسئلة تحتاج إلى كتابة الإجابة لتعذر وضع إجابات قياسيه .

٣ - المرئيات : يوجد فى نهاية معظم الأسئلة فراغات القصد منها رصد وجهة نظركم ومقترحاتكم حول موضوع السؤال . آمل أن تكتبوا فيها ما ترونه مفيداً فى موضوع البحث .

س ١ : كيف يتم تحديد مدة تنفيذ المشاريع فى ادارتكم ؟

ج ١ :

☐ يتم ذلك باتباع الوسيلة / الوسائل التالية وحسب النسب المذكورة :

- الآدارة العليا تحدد المدة : (تسخدم هذه الطريقة في ٪ من مشاريع ادارتنا)
ويتم ذلك كالتالى :
....
....
....

- الادارة الهندسية تحدد المدة : (تستخدم هذه الطريقة فى ٪ من مشاريع ادارتنا)
ويتم ذلك كالتالى :
....
....
....
....

- الاستشاري المصمم يحدد المدة (تسخدم هذه الطريقة فى ٪ من مشاريع ادارتنا) .
ويتم ذلك كالتالى :
....
....
....
....

☐ الطرق المذكورة بالفقرة السابقة لا تمثل أسلوب تحديد مدة تنفيذ المشاريع فى إدارتنا بشكل دقيق وانما يتم ذلك كالتالي :
....
....
....
....
....
....
....

☐ لا أدري في الحقيقة عن الطريقة المتبعة في إدارتنا لتحديد مدة تنفيذ المشاريع .

س ٢ : فى نظرك ما هى أهم العوامل التى يجب أخذها بالإعتبار عند تحديد مدة تنفيذ المشاريع ؟

ج ٢ : (من فضلك حدد درجة أهمية العوامل المذكورة) :

	مهم للغاية	مهم جداً	مهم	مهم أحياناً	غير مهم
– حجم المشروع	☐	☐	☐	☐	☐
– تصميم المشروع	☐	☐	☐	☐	☐
– ظروف الموقع	☐	☐	☐	☐	☐
– نوع المشروع (طرق ، مبانى ، ألخ) ..	☐	☐	☐	☐	☐
– تكلفة المشروع التقديرية	☐	☐	☐	☐	☐
– تقدير الإدارة العليا لحاجة المدينة للمشروع	☐	☐	☐	☐	☐
– المناخ السائد	☐	☐	☐	☐	☐
– قدرات المقاولين المتوقع عملهم بالمشروع .	☐	☐	☐	☐	☐
– (أخرى) حدد من فضلك :					
–	☐	☐	☐	☐	☐
–	☐	☐	☐	☐	☐
–	☐	☐	☐	☐	☐

س ٣ : هل تعتقد بأن تحديد المدة اللازمة للتنفيذ يأخذ حقه من الإهتمام في ادارتكم ؟

ج ٣ : ☐ يأخذ الإهتمام الكافي في جميع المشاريع .
☐ يأخذ الاهتمام الكافي في معظم المشاريع .
☐ يأخذ الاهتمام الكافي في بعض المشاريع .
☐ يأخذ الاهتمام الكافي في النادر من المشاريع .
☐ لا يأخذ حقه من الاهتمام أبداً .

س ٤ : هل ترى أهمية لتطبيق طريقة هندسية واضحه لتحديد مدة تنفيذ المشاريع ؟

ج ٤ : أرى أن ذلك :

☐ مهم للغايه .
☐ مهم جداً .
☐ مهم .
☐ مهم أحياناً .
☐ غير مهم .

س ٥ : ما هى فى نظرك أهم الآثار السلبية الناتجة عن وضع وقت قصير (أقصر من الوقت الكافى) لتنفيذ المشاريع ؟

ج ٥ : (من فضلك حدد مدى سلبية العوامل المذكورة)

	سلبي للغاية	سلبي جداً	سلبي	سلبي أحياناً	غير سلبي
- سوء التنفيذ لعدم إعطاء بنود العمل الوقت الكافي	☐	☐	☐	☐	☐
- زيادة الأعباء الإدارية المترتبة على خصم غرامات التأخير ومن ثم دراسة طلبات المقاولين بالإعفاء وتمديد العقود وما يتبع ذلك من كثرة المكاتبات وتشكيل اللجان	☐	☐	☐	☐	☐
- عزوف بعض المقاولين عن الدخول بالمشاريع لعلمهم بعدم إمكانية تنفيذها بالموعد المحدد .	☐	☐	☐	☐	☐
- صعوبة الإشراف حيث يتعذر تأمين الجهاز الفني الكافي لمتابعة أعمال المقاول	☐	☐	☐	☐	☐
- إرتفاع تكاليف التنفيذ	☐	☐	☐	☐	☐
- إرباك الإرتباطات المالية وتخطيط الميزانية ..	☐	☐	☐	☐	☐
- صعوبات في التنسيق مع الإدارات الأخرى ..	☐	☐	☐	☐	☐
- أخرى (حدد من فضلك) :					
-	☐	☐	☐	☐	☐
-	☐	☐	☐	☐	☐
-	☐	☐	☐	☐	☐

س ٦ : ما هي في نظرك أهم الآثار الايجابيه الناتجة عن وضع وقت قصير لتنفيذ المشاريع ؟

ج ٦ : (من فضلك حدد مدى ايجابية العوامل المذكورة)

	ايجابي للغاية	ايجابي جداً	ايجابي	ايجابي أحياناً	غير ايجابي
- تقليل التكاليف بتقصير مدة التنفيذ	☐	☐	☐	☐	☐
- تشجيع رفع المستوى الإداري للمقاولين وتحديث أساليب التنفيذ	☐	☐	☐	☐	☐
- تزيد من شعور المقاول بأهمية الوقت	☐	☐	☐	☐	☐
- اخرى (حدد من فضلك) :					
-	☐	☐	☐	☐	☐
-	☐	☐	☐	☐	☐
-	☐	☐	☐	☐	☐

س ٧ : ما رأيك في المدة التي تحددها إداراتكم لتنفيذ المشاريع :

ج ٧ : ☐ قصيرة جداً مقارنة بالوقت الطبيعي في ما نسبته ٪ من المشاريع .
☐ قصيرة في ما نسبته ٪ من المشاريع .
☐ مناسبة في ما نسبته ٪ من المشاريع .
☐ أطول من الوقت الطبيعي في ما نسبته ٪ من المشاريع .
☐ أطول جداً من الوقت الطبيعي في ما نسبته ٪ من المشاريع .

س ٨ : ما هى فى نظرك أهم الآثار السلبية الناتجه عن وضع وقت طويل لتنفيذ المشاريع ؟

ج ٨ : (من فضلك حدد مدى سلبية العوامل المذكورة)

	سلبى للغاية	سلبى جداً	سلبى	سلبى أحياناً	غير سلبى
- لا تشجع على تطوير أساليب الانشاء والإدارة	☐	☐	☐	☐	☐
- تشجع المقاولين على الدخول فى عدد كبير من المشاريع قد لا يستطيعون انجازها فى مواعيدها	☐	☐	☐	☐	☐
- سوء التنفيذ الذى قد ينتج عن عدم تتابع النشاطات الانشائية	☐	☐	☐	☐	☐
- أخرى (حدد من فضلك) :					
-	☐	☐	☐	☐	☐
-	☐	☐	☐	☐	☐

س ٩ : ما هى فى نظرك أهم الآثار الإيجابية الناتجة عن وضع وقت طويل لتنفيذ المشاريع ؟

ج ٩ : (من فضلك حدد مدى ايجابية العوامل المذكورة)

	ايجابى للغاية	ايجابى جداً	ايجابى	ايجابى أحياناً	غير ايجابى
- تساعد على خفض التكاليف	☐	☐	☐	☐	☐
- تساعد على التنسيق بين الجهات الحكومية وغيرها أثناء التنفيذ	☐	☐	☐	☐	☐
- تسمح بدخول عدد كبير من المقاولين فى المنافسة	☐	☐	☐	☐	☐
- أخرى (حدد من فضلك) :					
-	☐	☐	☐	☐	☐
-	☐	☐	☐	☐	☐

س ١٠ : من ترى يكون مسئولاً عن تحديد المدة اللازمة للتنفيذ ؟

ج ١٠ :

- ☐ الإستشاري المصمم
- ☐ القسم الهندسي في الإدارة (قسم المشاريع)
- ☐ الإدارة العليا
- ☐ جهود مشتركة من قبل المذكورين أعلاه .
- ☐ أخرى (حدد من فضلك) : ....

س ١١ : هل ترى أهمية لمطالبة المقاولين بتقديم جدول زمني للتنفيذ مع عطاءاتهم ؟

ج ١١ :

- ☐ مهم للغايه
- ☐ مهم جداً
- ☐ مهم
- ☐ مهم أحياناً
- ☐ غير مهم

س ١٢ : هل يطلب من المقاولين فى ادارتكم تقديم برنامج زمني للتنفيذ مع عطاءاتهم ؟

ج ١٢ :

- ☐ نعم ، في جميع المشاريع .
- ☐ نعم ، في معظم المشاريع .
- ☐ نعم ، في بعض المشاريع .
- ☐ نادراً ما يطلب ذلك .
- ☐ لا يطلب ذلك أبداً .

س ١٢ : ما رأيك فى الطريقة التالية لتحديد مدة تنفيذ المشاريع :
" تطرح المشاريع بدد مقترحه من الجهه صاحبة المشروع ويترك للمقاولين وضع مدة تنفيذ معينه من قبلهم ، بحيث تختار الجهه أفضل العروض تكلفة ووقتاً ثم يتم التعاقد على تكلفة ووقت محددين " .
علماً أن هذه الطريقة يقترح تطبيقها فى المشاريع التى لا ضرورة لتنفيذها بموعد معين مثل مشاريع الحج أو المدارس .

ج١٣ :

☐ أرى أن هذه الطريقة مناسبة جداً وستؤدي إلى انخفاض تكاليف المشاريع وتلافى سلبيات التأخير فى التنفيذ واقترح تطبيقها على جميع المشاريع ، كما أرى إن من ايجابياتها :
....
....
....

☐ أرى أن هذه الطريقة مناسبة وسيكون لتطبيقها مردود ايجابى مع مراعاة ما يلى :
....
....
....

☐ أرى أنه يمكن الاستفادة من هذه الطريقة ولكن بشكل محدود وفى بعض المشاريع وذلك كالتالى :
....
....
....

☐ أرى أن سلبيات استخدام هذه الطريقة أكثر من ايجابياتها وستجعل مهمة لجنة فحص العروض صعبة ولذلك فلا أعتقد أن من المناسب تطبيقها كما أرى :
....
....
....

☐ فيما يتعلق بهذا السؤال أرى : ....
....
....
....

س ١٤ : كيف ترى الطريقة المناسبة لتحديد مدة تنفيذ المشاريع ؟

" الرجاء هنا وضع تصوركم حول الأسلوب الذي يجب اتباعه في تحديد مدة تنفيذ المشاريع كما آمل كتابة ملاحظاتكم ومقترحاتكم حول النواحي التي ترون اخذها بالاعتبار عند تطوير طريقة لتحديد مدة تنفيذ المشاريع . كما أرجو الاشارة إلى ما تودون الادلاء به حول موضوع البحث " .

ج ١٤ : ....
....
....
....
....
....
....
....
....
....
....
....
....
....
....
....
....

« معلومات شخصية »

س ١٥ : مقدم الإستبيان :

ج ١٥ : ☐ مدير عام أو رئيس إدارة
☐ مدير إدارة هندسية
☐ مهندس تصميـــــم (مدني ، معماري ، كهربائي ، ميكانيكي ، .....)
☐ مهندس تنفيذ (اشراف) (" " " " ، ..)
☐ أخرى (حد د من فضلك):..............

س ١٦ : المؤهل العلمي :

ج ١٦ : ☐ بكالوريوس ☐ ماجستير ☐ دكتوراه

س ١٧ : عدد سنوات الخبره العملية

ج ١٧ : ....

س ١٨ : الخبرة العملية تتركز في مجال :

ج ١٨ : ☐ الطرق ☐ المباني
☐ مشاريع المياه والصرف الصحي ☐ المشاريع الميكانيكية والكهربائية
☐ أخرى (حدد من فضلك): ....

- من فضلك املأ الجدول التالي بخمسة مشاريع نفذتها إدارتكم (تكلفتها بين مليون ومائة مليون ريال):

مسلسل	سنة الاستلام	نوع المشروع	قيمة العقد (مليون)	مدة التنفيذ بالعقد (شهر)	المده التي استغرقها المقاول (شهر)	هل طلب المقاول التمديد	مدة التمديد (شهر)
مثال	١٣٩٧/٣٩٦هـ٠	طرق	١٥	٢٤	٢٧	نعم	٣
مثال	١٣٩٩/٣٩٨هـ	مباني	٤٧	٣٠	٣٦	لا	-
١	١٤٠١/٤٠٠هـ						
٢	١٤٠٣/٤٠٢هـ						
٣	١٤٠٥/٤٠٤هـ						
٤	١٤٠٧/٤٠٦هـ						
٥	١٤٠٩/٤٠٨هـ						

ايضاحات :

١ - نوع المشروع : طرق ، مباني ، زراعي ، ميكانيكي كهربائي ... العنصر الغالب في المشروع .

٢ - قيمة العقد : لاقرب مليون ، لا داعي لذكر المبالغ التي تقل عن مليون
٤١٢ر٨٥٠ر١ = ٢ مليون ٧١٩ر٤٥٠ر١٨ = ١٨ مليون

٣ - مدة التنفيذ : هي المده المحدده بالعقد لتنفيذ المشروع .

٤ - المدة التي استغرقها المقاول : المده الفعليه من تسليم الموقع وحتى استلام المشروع لأقرب شهر .

٥ - هل طلب المقاول التمديد : إذا ما كان متأخراً الاجابة : نعم ، أو لا

٦ - مدة التمديد : إذا كانت الجهه قد قررت تمديد المشروع .

٧ - سنة الإستلام : السنة التي تم فيها إستلام المشروع إبتدائياً ، والقصد من وضع السنوات في الجدول هو الحصول على عينة عشوائية ، الرجاء تعبئة الجدول بمشاريع مستلمه حسب السنوات المذكورة ، وفي حالة تعذر ذلك تعدل سنة الاستلام حسب الامكانية .

شاكراً تعاونكم ...

APPENDIX B

ENGLISH VERSION OF THE QUESTIONNAIRE

Q1. How is construction contract duration (CCD) set at your department?

A1.

CCD is set by the following method(s) and according to the specified percentages:

( ) Top management sets CCD and this is done as follows:

____
____
____

This procedure is used in ___ % of our projects.

( ) The Engineering Section in our department sets CCD, and this is done as follows:

____
____
____

This procedure is used in ___ % of our projects.

( ) The consultant sets CCD, and this is done as follows:

____
____
____

This procedure is used in ___ % of our projects.

Procedures mentioned above do not represent the procedure we use to set CCD, but we do it as follows:

____
____
____

I do not know how CCD is set in our department.

Q2: In your opinion, what factors should be considered when setting CCD? Please specify their degree of importance.

A2:	Extremely Important	Very Important	Important	Somewhat Important	Not Important
- Project Size	( )	( )	( )	( )	( )
- Project Design	( )	( )	( )	( )	( )
- Site Conditions	( )	( )	( )	( )	( )
- Project type (Roads, Build. etc.)	( )	( )	( )	( )	( )
- Project Estimated Cost	( )	( )	( )	( )	( )
- Top Management Assessment of the City/area need of the project	( )	( )	( )	( )	( )
- Weather Conditions	( )	( )	( )	( )	( )
- Expected qualifications of prospective bidders	( )	( )	( )	( )	( )
Others (Please specify:)					
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )

Q3: Do you think that the setting of CCD at your department receives enough attention?

A3:

- ( ) Yes, it receives enough attention in all projects.
- ( ) Yes, it receivces enough attention is most of the projects.
- ( ) Yes, but it receives enough attention only in some of the projects.
- ( ) No, it receives enough attention only in limited number of projects.
- ( ) No, it does not receive enough attention at all.

Q4: How important is it to apply a systematic engineering method to set CCD?

A4: I think it is:

- ( ) Extremely Important
- ( ) Very Important
- ( ) Important
- ( ) Somewhat Important
- ( ) Not Important

Q5: What are the negative consequences of setting a short CCD? Please specify the degree of negativity.

A5:	Extremely Negative	Very Negative	Negative	Somewhat Negative	Not Negative
- Poor performance by Contractors resulting from inadequate time allocation to work items.	( )	( )	( )	( )	( )
- Excessive adminis-trative burden resulting from delay claims.	( )	( )	( )	( )	( )
- Contractors unwilling-ness to bid because they know the project cannot be done within the specified time.	( )	( )	( )	( )	( )
- Supervision difficulties	( )	( )	( )	( )	( )
- High bid prices	( )	( )	( )	( )	( )
- Disruption of budget planning and financial planning	( )	( )	( )	( )	( )
- Coordination difficulties	( )	( )	( )	( )	( )
- Others (Please specify):					
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )

Q6: What are the positive consequences of setting a short CCD? Please specify the degree of positivity.

A6:	Extremely Positive	Very Positive	Positive	Somewhat Positive	Not Positive
- Low bid prices due to short construction period	( )	( )	( )	( )	( )
- Promoting effective management and innovation.	( )	( )	( )	( )	( )
- Raising the contractor's awareness of time importance	( )	( )	( )	( )	( )
Others (Please specify)					
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )

Q7: What do you think of the CCD set by your départment?

A7: ( ) Very short in about ___ % of our projects

( ) Short in about ___ % of our projects

( ) Reasonable in about ___ % of our projects

( ) Long in about ___ % of our projects.

( ) Very long in about ___ % of our projects.

Q8: What are the negative consequences of setting a Long CCD? Please specify the degree of negativity.

A8:	Extremely Negative	Very Negative	Negative	Somewhat Negative	Not Negative
- Discouraging Effective management and innovation	( )	( )	( )	( )	( )
- Encouraging contractors to bid more work than can be handled in a timely manner	( )	( )	( )	( )	( )
- Leading to poor performance resulting from discontinuous operations (relaxed schedule)	( )	( )	( )	( )	( )
Others (Please specify)					
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )

Q9: What are the positive consequences of setting a Long CCD? Please specify the degree of positivity.

A9:	Extremely Positive	Very Positive	Positive	Somewhat Positive	Not Positive
- Low bid prices	( )	( )	( )	( )	( )
- Good coordination with other agencies	( )	( )	( )	( )	( )
- Permitting more contractors to bid	( )	( )	( )	( )	( )
Others (Please specify)					
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )
-	( )	( )	( )	( )	( )

Q10: Who do you think should be responsible for setting CCD?

A10: ( ) Consultant
( ) Engineering Department
( ) Top management
( ) Joint effort by all mentioned above
( ) Others (Please specify)

____
____
____

Q11: How important is it to request contractors to submit construction schedules with their bids?

A11: I think it is,
( ) Extremely important
( ) Very important
( ) Important
( ) Somewhat important
( ) Not important

A12: Do you request bidders to submit construction schedules with their bids?

A12: ( ) Yes, in all projects
( ) Yes, in the majority of projects
( ) Yes, in some of projects
( ) We seldomly request it
( ) Never

Q13: Please evaluate the following method of setting CCD.
(Projects are sent for tendering with a suggested CCD by owners' contractors are to set their own CCD and submit construction schedules, then owners select the best offer in terms of price and time).

A13: ( ) I think this method is very suitable and applicable to all projects since it will result in low bid prices and avoidance of negative consequences of time over-runs.

Other advantages of this method include:

____

____

____

( ) I think this method is suitable and applicable to most projects depending on the following considerations (conditions):

____

____

____

( ) I think it is possible to use this method but only in some projects depending on the following considerations (conditions):

____

____

____

( ) I think this method is not suitable since it will make the task of the bid inspection committee difficult. Other disadvantages of this method include:

____

____

____

( ) Regarding this question, I think,

____

____

____

Q14: What method do you consider the best for setting CCD?
(Please write your opinions towards possible procedures to be applied to set CCD including factors to be considered when developing a methodology for this purpose, and your views of the subject of the research).

A14:

____

____

____

Q15: Respondent's position:

A15: ( ) General Director
( ) Engineering Department Manager
( ) Design Engineer
( ) Construction Engineer
( ) Others (Please specify)

____
____
____

Q16: Education

A16: ( ) B.S.
( ) M.S.
( ) Ph.D.

Q17: Years of Experience

A17: ______________________________

Q18: Experience is concentrated in:

A18: ( ) Roads
( ) Buildings
( ) Water & Sewerage Projects
( ) Electro-mechanical Projects
( ) Others (Please specify):

____
____
____

TIME PERFORMANCE OF CONSTRUCTION PROJECTS.

Please fill the table below with 5 of construction projects executed by your department.

(Cost between 1 and 100 million Saudi Riyals)

No.	Year of Turn-over	Project type	Contract Value SR Million	CCD specified by contract (Months)	Actual CCD (Months)	Extra time requested by contractor	Extra time given to contractor
Ex.	1976-1977	Road	15	24	27	3	3
Ex.	1978-1979	Building	47	30	36	-	-
1.	1980-1981						
2.	1982-1983						
3.	1984-1985						
4.	1986-1987						
5.	1988-1989						

Contract Value: Rounded off to the nearest million SR.

Year of Turnover: The year during which the project was turned over to the owner, please fill the table with projects turned over in the specified years, if not available, make the necessary corrections.

REFERENCES

Agresti, Alan, Analysis of Ordinal Categorical Data, John Wiley & Sons, New York, 1984.

Anderson, D., Sweeney, D., and Williams, T., Statistics for Business and Economics, West Publishing Company, St. Paul, 1981.

Bernstein, C.S., "Highway Projects - Can They be Done in Half The Time", Civil Engineering, ASCE, Sep. 1983, pp. 50-54.

Browmilow, F.J., Hinds, M.F. and Moody, N.F., "ALQS Survey of Building Contracts Time Performance", The Building Economist, Vol. 19, No. 2, September 1980, pp. 79-82.

Carr, Robert I., "Simulation of Construction Project Duration", Journal of the Construction Division, ASCE, C02, June 1979, pp. 117-128.

Clough, R., "Construction Project Management", Wiley- Interscience, New York, 1972.

Defranchi, Ettore E., "Economic Planning: A Method to Obtain Cost Effectiveness in the Construction Industry", Proceedings of the Project Management Institute, 15th Annual Seminar/Symposium: Houston, USA, 1983, pp. V-K-1 - V-K-10.

"Fourth Development Plan, 1405-1410 A.H. - 1985-1990 A.D.", Ministry of Planning, Riyadh, 1985.

Galloway, Patricia and Nielsen Kris, "Scheduling Control for PCM Projects," Journal of the Construction Division, ASCE, CO2, June 1981, pp. 323-335.

Gates, M., and Scarpa, A., "Optimum Working Time", Transportation Engineering Journal, ASCE, Vol. 103, No. TE6, November 1977, pp. 773-781.

Gates, M. and Scarpa, A., "Preliminary Time and Overhead Estimates by the One-Third Rule", Cost Engineering, Vol. 22, No. 6, December 1980, pp. 331-338.

Guilford, J.P. and Fruchter, B., Fundamental Statistics In Psychology and Education, McGraw-Hill, 1978.

Hancher, D. and Rowings, J., "Setting Highway Construction Contract Duration", Journal of the Construction Division, Vol. 107, ASCE, (C02), June 1981, pp. 169-179.

Al Hazmi, M., "Causes of Delay in Large Building Construction Projects", M.S. Thesis, KFUPM, June 1987.

Heineck, D.F., "A Model to Estimate the Duration of Work on House Building Sites". Proceedings of the 4th International Symposium on Building Economics, CIB-W-55, Danish Building Research Institute, Copenhagen 1987; pp. 73-84.

Hindrickson, Kris, Martinelli, David, and David Rehark, "Hierarchical Rule-Based Activity Duration Estimation", Construction Engg. & Mgt. Journal, ASCE, Vol. 113, CO2, June 1987, pp. 228-301.

Hira, N., Ahuja and V. Nandakumar, "Enhancing Reliability of Projects Duration Forecasts". Transactions of AACE, 1984, pp. E.6.1 - E.6.12.

Johnston, D.W., "Linear Scheduling Method for Highway Construction", Journal of the Construction Division, ASCE, Vol. 107, CO2, June 1981, pp. 247-261.

Khan, M.A., "Small Sample Comparison of X^2, B, G and FT Goodness of Fit Test", Pakistan Journal of Statistics, Vol. 4, January 1988, No. 1, Series A., pp.

Panagiotakopoulos, D., "Cost-Time Model for Large CPM Projects Network", Journal of the Construction Division, ASCE, Vol. 103, No. CO2, June 1977, pp. 201-211.

Perera, S., "Linear Programming Solution to Network Compression", Journal of the Construction Division, ASCE, Vol. 106, No. CO3, September, 1980, pp. 315-326.

Roncoli, M., "Computerized Cost Optimization Scheduling", M.S. Thesis, University of Florida, Fall 1986.

Selinger, S., "Construction Planning for Linear Projects", Journal of the Construction Division, ASCE, Vol. 106, No. C02, June 1980, pp. 195-205.

Sidewell, A.C., "The Time of Construction Projects", Architectural Science Review, Vol. 27 n4, Dec. 1984, pp. 85-91.

Smith, G., A Conceptual Construction Project Planning Model, Ph.D. Dissertation, Purdue University, 1986.

Soeterite, F.W., and Foster, P.K., "Research Into Time/Cost Performance of New Zealand Building Contracts", Report No. 22. The Building Research Association of New Zealand, Wellington, 1976.

"Statistical Year Book of 1407 A.H. - 1987 A.D." General Department of Statistics, Ministry of Finance and National Economy, Riyadh, 1987.

Thomas, H.R., Jones, J.R., Willinbrock, J.H., Hester, W.T., Logow, P.A., "Comparative Analysis of Time and Schedule Performance on Highway Construction Projects Involving Contract Claims", Nittany Engineers and Management Consultants, Inc.

Transportation Research Board, National Research Council, "Contract Time Determination", National Cooperative Highway Research Program. Synthesis of Highway Practice No. 79, Washington, D.C. 1981.